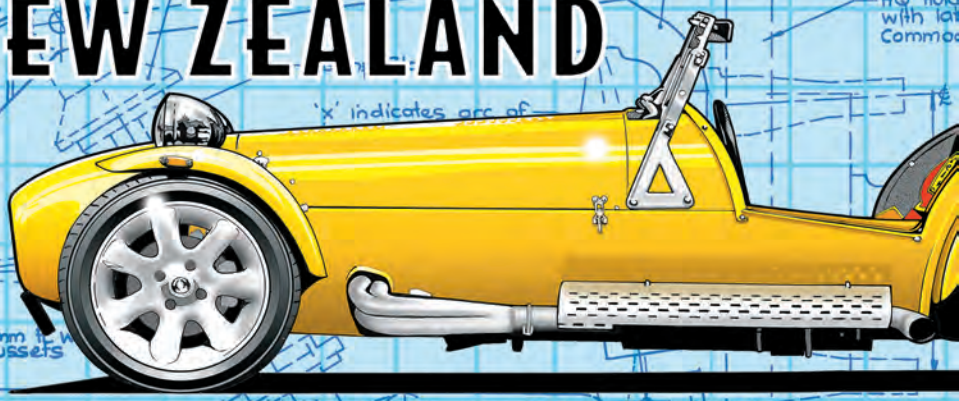
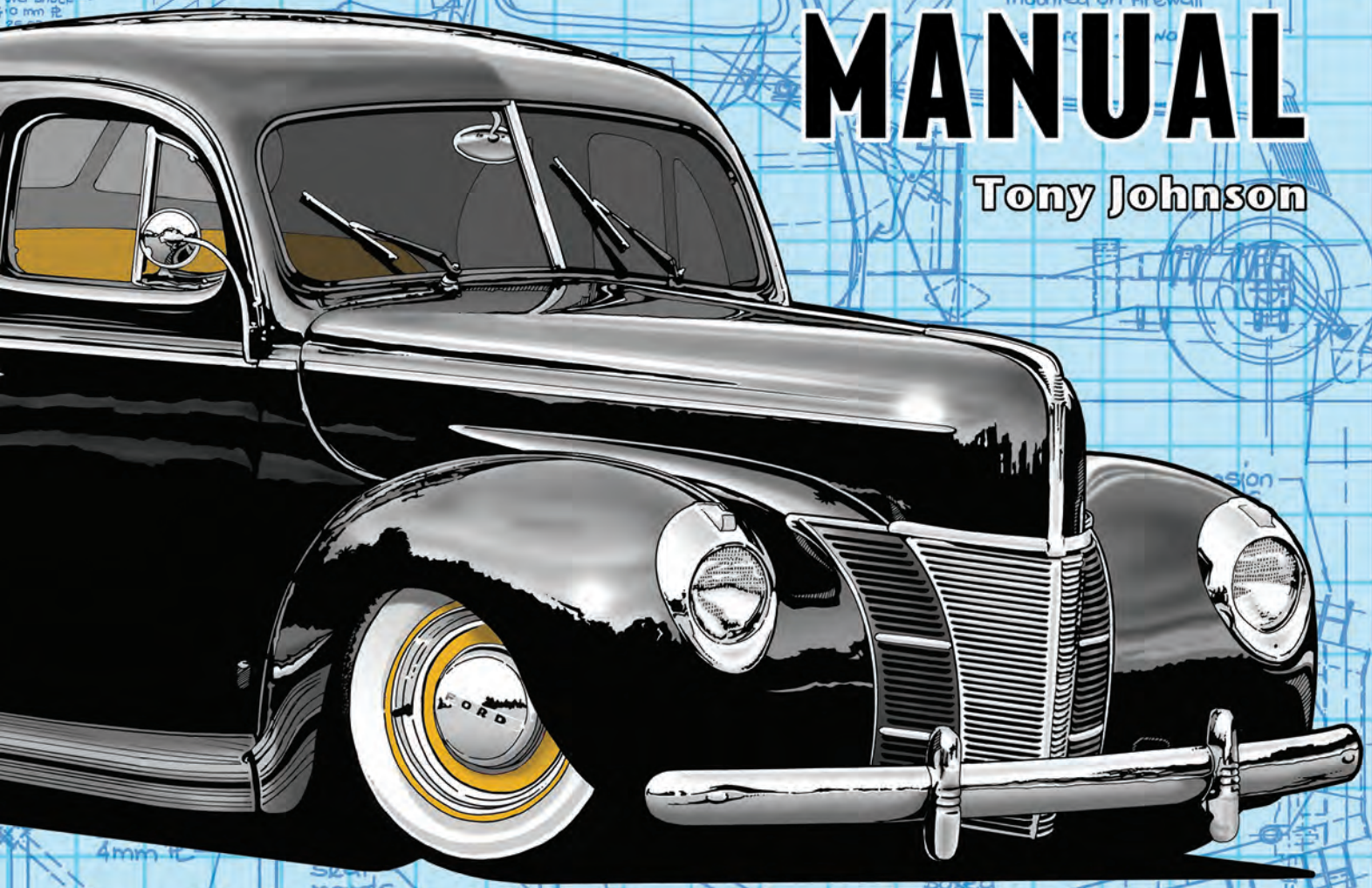
THE NEW ZEALAND CAR CONSTRUCTION MANUAL





Tony Johnson

Low Volume Vehicle Technical Association (Inc.)

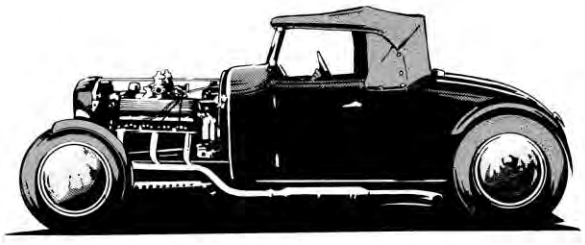
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The New Zealand Car Construction Manual was written by Tony Johnson of Auckland New Zealand, for the NZHRA, who originally commissioned the development of the Manual in 2002. Tony has continued to take responsibility for the on-going amendments to the Manual for NZHRA, and for LVVTA since LVVTA took ownership of the Manual in October 2010.

Tony is a self-employed illustrator, journalist, technical writer, and automotive consultant, and is a member of various car clubs and associations.

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NZHRA, and its key personnel, have, and continue to since the inception of LVV certification, form the back-bone of the LVV certification system in New Zealand. LVVTA is very appreciative of NZHRA's on-going commitment and integrity.

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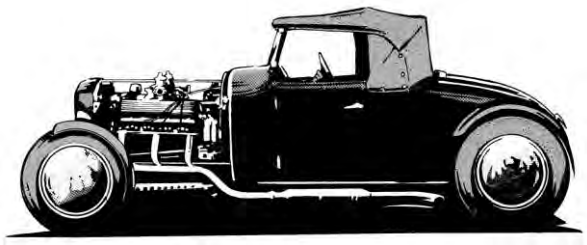
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Introduction

From there to here

So, here we all are then, a decade and a half since, as a group of home-built hobby car enthusiasts, we heard the ominous whispers that the New Zealand Government was cooking up some new rules that were going to bring our ability to build hot rods and sports cars and kit cars, with all of the traditional freedoms that ingenious Kiwis had enjoyed for so long, to an abrupt and painful end. The new politically-correct and safety-focused world had finally caught up with us.

Looking back to 1990, it's now obvious that it was with enormous vision and impressive courage that Richard (Dick) Reynolds, 'Controller of Vehicle Standards' at the Ministry of Transport, after having suffered a year-long education process from a few hot rodders during 1989, gave us a tentative green light to 'self-regulate'. Dick said to us, in his wonderfully straight-forward and un-PC style of telling it like it was, back in an era when a government boss could still get away with smoking in his office and having the odd Port before five o'clock, "...well bugger off then you noddies and have a go at writing your own rules, if you really think you're so smart..." So, we busted our backsides for two years to raise a bunch of money, write the original Code of Construction Manual, develop a certification system, and recruit a group of hot rodders to carry out the inspections. Then, in early 1992 we presented the whole shebang to Dick, and held our fingers tightly crossed behind our backs...

The end product must have been near enough, and good to his word, Dick said to us, "get on with it then - and you'd better bloody well hurry up about it, too". New Zealand's low volume vehicle certification process was on its way. We had somehow managed to head off the Australian Design Rules, and the professional transport engineers, the likely outcomes of which were both as unattractive as the other. That gamble that Dick took on us marked the beginning of a long and complex journey of continuous improvement, that, despite having achieved massive progress, still somehow seems today as if we are as far from finished as we were 15 years ago.

Dick assigned us a new Ministry of Transport Engineer by the name of Andrew Justice, who was to become our day-to-day contact, and who would many years later, despite his British education and engineering degree, become intimate with, and thoroughly confident in, our practically-oriented Kiwi way of doing things – making sound technical decisions on the basis of real-world experience, historical knowledge, and the intuitive and instinctive skills of practical hands-on people with huge expertise, developed purely from a lifetime of building and modifying motor cars. That very approach still forms the strong backbone of the low volume vehicle certification system today, and indeed, is almost entirely what the content of this NZ Car Construction Manual is based upon.

With no precedents of a good modified vehicle system to follow anywhere else in the world back in the early 1990s, the Ministry of Transport and the hobby car fraternity, strongly led by the New Zealand Hot Rod Association, formed a solid relationship based on mutual respect and trust, and nurtured and evolved Dick's 'gut-feel' punt into something that is now generally recognised within both the New Zealand Government and the hobby car fraternity of New Zealand as being the best low volume vehicle system anywhere in the world. Here, we have a true win-win situation; the rules are written by enthusiasts for enthusiasts, so from a practical point of view, the system works. The hobby car fraternity however takes their privileged position and their responsibilities hugely seriously, to the extent that the Government legislators know that there is no other system by which modified and scratch-built vehicles could be so well engineered, and so thoroughly assessed. Consequently, we have been rewarded for our efforts since 1989, by finding ourselves now living in an environment where we can still build a fenderless '32 Roadster, or a tubbed and supercharged '57 Chevy - no mean feat in this heavily regulated age.

Dick Reynolds has long since retired, and very sadly, Andrew Justice, our main man within the Ministry of Transport and subsequently Land Transport New Zealand, who was such a great supporter and advocator of our practically-oriented system, and who became a great mentor and friend to us, died suddenly in 2005. Between them though, they enabled the foundations to be poured for the solid ground upon which, as hobby car builders and modifiers in New Zealand, we now stand. I wish Andrew could have seen this completed manual – I know he would have been very proud of the end result.

In order to preserve our future ability to continue to build and modify cars, we now, as ever, must stay safety-focused, remain diligent, and maintain our good relationship with the Government. The roughest seas however are now behind us, and we should never again see another chapter in the book of the New Zealand motor car hobbyist that is as challenging, difficult, and traumatic as this past decade and a half has been.

Cherish and encourage

The hobby car movement, and hot rodding in particular, has truly come of age in New Zealand, achieving a far greater and more legitimate profile than we could have dreamt of having 30 years ago. Now, a scratch-built hot rod, be it from the commercial stables of John Reid or Terry Bowden, or from the home-garage of a clever home-builder, are now, together with the ingenious people who build them, getting the recognition and respect they deserve, from throughout the whole motor industry and the wider community beyond.

New Zealand has never had a real car manufacturing industry, and even its car assembly industry is now lost. Today, the high quality professional hot rod shop or home-builder has become New Zealand's ultimate expression, and last bastion, of automotive engineering creativity, artistry, ingenuity, and individuality. No doubt finely honed by years of geographical isolation and high import costs and restrictions, the top-end Kiwi hobby car builder has evolved into a being with an uncanny and instinctive ability to design and fabricate incredible automotive creations – all without the luxuries of big budgets, plans, prototypes, testing, formal qualifications, or even textbooks.

Clever automotive engineering, is of course, part of our New Zealand heritage – Graham McRae, Bert Munro, Bruce McLaren, John Britton, and many others have given us our international automotive engineering profile. Today, there are countless clever car people from this tiny speck at the bottom of the planet, whose engineering, fabrication, and mechanical skills are respected, admired, and sought after by race teams within every major motor racing championship around the world. Overseas race car and hot rod shops clamour to employ Kiwi car builders, and precious and valuable cars are sent to New Zealand for the top-class restoration work that wealthy overseas collectors have come to expect.

Our car building and modifying hobby is big - bigger than many people realise. Remind anyone who suggests otherwise, that America's aftermarket automotive industry is worth over *thirty billion* US dollars annually. And it's not just home-garage petrolheads like us that are spending up large. The hot rod – long regarded as one of America's greatest cultural icons - is being embraced by even the corporate giants of the world, in order to promote their products and their profile at every opportunity. The General Motors Corporation have for some years been commissioning the Los Angeles-based So-Cal Speed Shop to build a number of special one-off vehicles for them (one of the principle craftsmen of which, by the way, is our own Kiwi hot rodder, drag racer, and past LVV Certifier Robin Silk) both as styling exercises, and for competition use. And as GM's main rival, the Ford Motor Company, prepared for the 75th anniversary of the iconic 1932 Ford, it did so by headlining their celebrations with a specially commissioned limited production run (by an independent hot rod shop) of brand new '32 Ford Roadster hot rods, along with undertaking the huge logistical exercise of identifying and assembling 75 of America's most influential and historically significant 1932 Ford-based hot rods, at one place at one time for enthusiasts worldwide to enjoy.

We are part of a truly great hobby, and a hobby that, by its very nature, needs special protection from regulatory zealots, over-the-top greenies, and everyone else who advocates a society that would disallow people to take responsibility for their own decisions and actions. By working with the Government and the Low Volume Vehicle Technical Association, and by taking a sensible and pro-active approach to motor vehicle safety, the New Zealand Hot Rod Association is playing an important role in preserving the ability of Kiwi hobby car enthusiasts to keep on doing what they so love, and what they are so good at, even within the context of a country that has always been, and will always be, massively over-regulated.

Ironically, one of the most profound statements about us hobby car people that I've ever read or heard came not from one of our own, but from a senior manager within the Ministry of Transport. Having got to know us well whilst with the Ministry, Lesley Emmett offered us some thoughts on our system and our clever hobby car builders when leaving the Ministry to head back home overseas. I quote from Lesley's goodbye letter: *"...There are few enough real, practical, and innovative people left in this world, that we should cherish and encourage those we have got, rather than seeking ways to restrict and inhibit them, since theirs is the true spirit of what has taken humanity through the 20th century, and helped to create the world we have today, in so many ways..."*

What incredibly wise and refreshing words! If only everyone else in a position to affect our future had Lesley's vision - but sadly, the reality is that most don't. The road ahead, therefore, will never be entirely smooth. There will always be a very fine balancing act for the car hobby between working to protect our freedom as enthusiasts, to be innovative, and to be able to build what we want - against diligently working to come up with better ways to provide our passengers and those road users in the on-coming lane with the levels of safety engineered into our hobby cars that those passengers and other road users should rightly be entitled to.

With the groundwork of the past decade and a half now behind us, helping the Low Volume Vehicle Technical Association to maintain this balance is the next challenge for the New Zealand Hot Rod Association. So, welcome to the first step towards that very goal – the new 'New Zealand Car Construction Manual'.

I hope that you've managed to hang on during the last 15 years' ride, and that your ride through the next 15 years will be better, and I especially hope that this new manual will help you to build and enjoy your next hot rod, sports car, modified classic, or whatever it is that smokes your tyres and puts a gleam in your eye...

TJ.

Acknowledgements

The development of this NZ Car Construction Manual has been a huge team effort over a six-year period, and there are many people who deserve recognition for their part in it.

The Technical Advisory Committee

The heart and soul of this manual has come from the NZHRA members who sit on the Technical Advisory Committee (TAC), and who have given untold evenings over the six-year period, all on a voluntary basis, in order to achieve the countless technical decisions upon which this manual is based.

Getting the technical content worked out and agreed has been a much more time-consuming and difficult process than any of us might have imagined it would be, when we started down this track in 2000. But, we've got there, and that's primarily thanks to the experience, expertise, and dedication of the TAC members. Here's a very brief introduction of the team that provided all of the engineering and mechanical knowledge that makes up the manual:

- Alan Small; fitter/turner by trade with 40 years in the engineering industry, been in hot rodding since 1963 (in North Shore R&CC for most of that time), crew-chief for 'Hombre' and 'Baloo' hemi altereds in the '60s and '70s, and has raced cars of some sort since 16 years of age. Currently owns a self-built Model-A roadster hot rod, and races a Gurney Ford-powered speedway midget.

- Chris Litherland; senior aircraft engineer for Air New Zealand, hot rod club member (Southside Streeters, Papakura HRC) since 1973, has built top-level '23 T-bucket and '32 Tudor hot rods, past LVV certifier, been on the TAC since 1993, designer and builder of the test-rig used to prove or disprove some of our hot rod engineering theories, and is in recent years involved in general product inventing.

- Geoff Cottle; automotive engineer (heavy equipment) by trade, has owned and operated mechanical and auto electrical company for 20 years (Cottle Motors and Electrics in Kumeu), hot rod club member (Harbour City and Midwest) for 16 years. Has raced speedway midgets, and currently owns blown '23 T-bucket (built while still at school) '37 Ford sedan hot rod, and '34 Chev sedan hot rod.

- Graham Walls; mechanical draughtsman by trade, been in hot rodding for 30 years (Harbour City Rod Club), Life Member of NZHRA, CAD-illustrator extraordinaire (responsible for the CAD diagrams in this manual), TAC member since its inception in 1990, and currently in the final stages of his own fenderless '34 Ford coupe hot rod.

- John Reid; auto electrician by trade, also worked in heavy transport engineering and hydraulics, hot rod club member since 1966, founder and Life Member of Riverside Rodders, has built top-level hot rods since 1968 ('Vandal'/'Black Sabbath' Dodge bucket, 40 Ford pick-up, 'Elderberry Wine' Model-A sedan-delivery, 'Billet' Model-A coupe), professional hot rod builder (Rods by Reid in Tauranga) for over 20 years. Currently owns self-built '33 Ford coupe hot rod, and is building a '32 Ford pick-up hot rod.

- Mark Stokes; motor mechanic, mechanical workshop owner for 20 years, raced go karts, crewed on midgets, production saloons, Bonneville land speed record car, and crew-chief on Targa car (NZ and Australia) and Wild Bunch drag car. Hot rod club member (Auckland, Franklin, Southside) since 1972, currently involved in racing vintage speedway midgets, and owns restored and custom motorcycles, self-built blown Model-A roadster pick-up hot rod, '60 Ford Starliner, and building blown Porsche-engined '32 Ford. Has been an LVV certifier since 1995.

- Paul Sattler; qualified auto electrician and qualified motor mechanic, has also worked in light engineering and engine building, 35 years in hot rodding and drag racing, as well as a stint in off-shore power boat racing, hot rod club member (Yankee Haulers and Whakatane) since 1972. Owns self-built street & strip Model-A Ford coupe hot rod, '42 Ford sedan hot rod, races a blown and injected Chev-powered front-engined dragster, and holds a world land speed record. LVV Certifier since system began in 1992.

- Terry Bowden; fitter/turner by trade, professional hot rod and drag race car builder for 15 years (Terry's Chassis Shop in Auckland), and widely considered to be NZ's leading drag race car builder. Long-time hot rod club member (North Shore R&CC, Pukekohe HRC), previously raced his own 10-second 'Insane' T-bucket, involved in several championship-winning Super Stock drag cars, builder/owner/crew-chief of Australasia's quickest 4-cylinder drag car, now crew-chief of the quickest and fastest Pro-import drag car on planet earth.

The input of these guys into the development of the new Car Construction Manual has been enormous – a fantastic effort chaps - a huge thanks to all of you. Future generations of hot rodders and other hobby car builders to come, will, I'm sure, be massively grateful and appreciative of what you have done for them.

And amongst this great team of experts, special appreciation must be extended to Tauranga's Paul Sattler and John Reid. Thank you guys, not just for your input at the TAC meetings, but for making the 6-hour round trip from Tauranga to attend the majority of the monthly TAC meetings held in Auckland over the last six years. An awesome effort Pins and JR; - your technical input has been immeasurable, your commitment staggering, and your sense of humour greatly appreciated!

Co-opted Technical Advisory Committee members

Others from outside the NZHRA membership have helped us to make this a true 'car' construction manual, rather than a document devoted to just hot rods, as was the original Code of Construction Manual. These people also, have contributed a great deal of voluntary time to attend TAC meetings, and have been a great help.

These helpers include Andrew Denton, Walter Wing, and John Ward from the Sports Car Club of New Zealand, who have made sure that the light-weight home-built sports car builder is well catered for within the new manual. Special thanks amongst those from the Sports Car Club of New Zealand must go to John Ward, who has contributed an absolute wealth of engineering and mechanical expertise in the area of lightweight specials over a long period of the manual's development time. Other co-opted helpers include Peter Vahry from the New Zealand Four Wheel Drive Association, and Kerry Buchanan from Kiwi Trikers Social Club.

From time to time, the TAC have sought additional support and advice from people who have special expertise in certain areas, including Dave McDougal (D&V Autos) of Kumeu who put in a big effort during the first couple of years of the manual's development, and has always been willing to provide great advice. Les Hunter of Christchurch (Les Hunter Automotive) was a huge help with the braking component information you'll see in Chapter 8, plus Geoff Dixon of BG Marketing and Paul Weir gave us input on wheels, and 'Mopar' Mike Walters advised on glazing.

Submitters and reviewers

Several people made excellent initial submissions when this project began; many thanks to hot rodders Rick Murray, Neal Miller, Redvers Charles, Stephen Monteperto, Steve Rhodes, Jeff Marshall, Brett Wells, Graeme Doree, and Leon Sutherland. Great input guys - nearly all of it was used.

Another group of hobby car experts from throughout the country reviewed the various chapters as the TAC finished their part, feeding back excellent comments and suggestions, and introducing many new ideas. Many thanks to hot rodders Jon Elley, Gary Martin, Neal Miller, Barry Pope, Redvers Charles, Peter Watson, Andrew Smith, Lloyd Wilson, and Les Dick, along with enthusiasts of other automotive denominations Dan Martin and Ewan Fisk. Group submissions came from the members of New Zealand Four Wheel Drive Association, Constructors Car Club, and the Wellington Regional Certifiers' Group, all of which was very useful and much appreciated.

NZHRA Certifiers

To all of the past and present LVV Certifiers from the NZHRA hot rodding community, I would like to thank you for playing a part in evolving the LVV system to where it is now – which has enabled this new Car Construction Manual to be developed - by being an LVV Certifier at some stage. Sadly, a few great guys, including Maurice Hipperson and Pete Dore, are no longer with us.

Extra special appreciation must go to some of the LVV Certifiers who come from the NZHRA hot rodding community, and who have been scratch-built-authorised LVV Certifiers since the system's inception in March 1992, and still remain so now 18 years later. You blokes have provided, and continue to provide, the strong and stable backbone of the LVV certification system. The expertise, experience, and integrity of you guys forms a major part of the reason for the low volume vehicle system's success to date.

They are: Noel McMillin (Hamilton), Neal Miller (Hamilton), Paul Sattler (Tauranga), Steve Hildred (New Plymouth), Grant Rivers (Wanganui), Andrew Smith (Levin), Don Hoff (Christchurch), Jon Palmer (Timaru), Roy McDonald (Dunedin), Graham Fitzpatrick (Dunedin), and Barry Pope (Invercargill).

There are other people from the NZHRA hot rodding community that dived in soon after the system started and have stuck with it, applying the same level of diligence and skill as those listed above. They are: Mark Stokes (Auckland), Dean Longhurst (Rotorua), Marty Jones (Palmerston North), Danny McKenna (Palmerston North), Julian Cheer (Wairarapa), Brent Pahl (Nelson), Steve Rhodes (Timaru), and Peter Watson (Gore).

To all of you guys, we're all hugely grateful to you for being there, and enabling the LVV system to continue and to improve, so that we can all still build the cars that are so near and dear to our hearts.

The knowledge that these LVV Certifiers have accumulated over the past 18 years, on top of what they already knew at the start, would make your head spin. They've seen it all, both good and bad, and the help and advice that they can provide you during the LVV certification process as your project progresses, is truly priceless. Auckland's Mark Stokes, for example, has LVV certified over 7000 modified and scratch-built cars – the resultant knowledge and expertise on those shoulders is beyond imagination. Much of the content of this manual has come from what these experienced LVV Certifiers have seen and learnt, and passed on to us over their years of involvement.

NZHRA has a list of NZHRA-endorsed LVV certifiers listed on their website (www.hotrod.org.nz), and they encourage you to use these LVV Certifiers for your next project.

Others

I'd like to express my appreciation to the members of the Executive Committee of NZHRA (some of whom have been and gone during the development of this manual) for having the foresight and the patience to maintain priority on getting the job done right, even though it's taken a lot longer than we'd all initially planned. Amongst them, I'd like to say a special thanks to 'Bonneville Chris' Harris and Errol Uttinger for staying so positive throughout the job, and giving me the necessary encouragement to stick with it, despite the hurdles and the enormity of the job.

Thanks also to the Management Committee of the Low Volume Vehicle Technical Association (Inc) (LVVTA); Steve Keys, Neil Fraser, Ian Snellgrove, and Graeme Banks for recognising that I had to drop LVVTA work from time to time to get this done, even though there wasn't really time available to do so. Thanks to previous LVVTA people, Glenn Johnston (now retired), Doug St George, and Kendall Bradley, for helping me out by assisting with the LVVTA workload and attending TAC meetings, and Linda Washington, who has been an awesome helper and supporter all the way through the job with copying, distributing, collating, general administration, and most importantly - helping me to make the time to write the manual.

TAC member Graham Walls of Harbour City Rod Club is an absolute legend – he's the sole remaining member of the original TAC group that helped me to write the original Code of Construction Manual from 1990 to 1992, and again, as well as providing valuable technical input and being the most solid and reliable guy on the planet, he's been the provider of the brilliant technical CAD-diagrams throughout the manual.

Many thanks to the proof-reading team, a job that on its own consumed well over 200 hours, and like everyone else mentioned here, all done on a voluntary basis; Linda Washington, Linda's mum Gwen Washington, and my scholarly sisters Rachael Haverkamp and Raewyne Johnson ('Speedy & Fussy').

Thanks also to an incredibly patient Auckland-based computer guru by the name of Tony Pelham (www.pcwin.homestead.com) for his first-class computer technology support, and outstanding computer programme-use tuition, whenever I struck problems or needed to learn new things during the process of typesetting and formatting this document. A truly brilliant bloke.

Lastly, many thanks to all the NZHRA members who have patiently waited (for far too long) for this NZ Car Construction Manual to be completed. Hopefully, the technical expertise that the TAC guys and all the helpers have put into this manual will help you with the next car you build or modify in some way. I wish you all the very best of luck with your current and future hobby car projects, and lets all recognise that, thanks in no small part to the help of everyone acknowledged in these pages, our kids and grand-kids will all be able to continue building and driving hot rods, sports cars, or whatever it is that gives them their buzz, for many decades to come.

TJ.

Updates and Amendments

Obtaining Updates and Amendments

Updates and amendments will be developed for this manual by the Low Volume Vehicle Technical Association (Inc) (LVVTA) on an as-and-when-required basis, and distributed by LVVTA.

So that the purchaser of this manual (the 'manual-holder') can be notified of the availability of any updates and amendments, the manual-holder must fill in the Manual-holder Database Registration Form at the bottom of this page, and forward it (a photocopy of this page is acceptable) to LVVTA after purchase. This will enable LVVTA to build and maintain a database of manual-holders so that each manual-holder can be contacted when an update or amendment becomes available, informed of the content, and how to go about receiving it. If a manual-holder requires a hard copy to be posted, there will be a nominal charge for each update or amendment to cover LVVTA's copying, handling, and postage costs.

Alternatively, manual-holders can access chapters from LVVTA's website, free of charge, at any time.

It is very important that manual-holders provide the following details on the Form below:

- E-mail address; e-mail is the preferred method of distributing the update and amendment notification – if you do not have your own e-mail address, consider using someone else's.
- Postal address; a physical postal address gives LVVTA a second method of notifying manual-holders if there is a problem with providing electronic notification.
- Your CCM #; you must provide your unique NZ Car Construction Manual number. Update and amendment notification will only be issued to those bonafide manual holders who are recorded on the LVVTA manual-holder database, and who can provide their unique CCM #. Your unique CCM # is printed at the top right-hand corner of the Contents page.
- Your association or club, and affiliation/membership # (where applicable); this is so that your membership can be confirmed to enable your manual purchase at the discounted rate available for members of associations and clubs that are member associations or clubs of the LVVTA.

Note that it is the responsibility of the manual-holder to inform LVVTA of any email or postal address changes - LVVTA will not take any responsibility for delivery failure of any update and amendment notifications if the manual-holder's postal details have changed and LVVTA has not been informed.

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Forward this completed form to LVVTA at: admin@lvvta.org.nz or P. O. Box 50-600, Porirua City 5240, New Zealand.		

Record of Updates and Amendments

As updates and amendments are issued by the Low Volume Vehicle Technical Association (Inc), a new Record of Updates and Amendments page will be issued. The manual-holder should replace the existing Record of Updates and Amendments page with this new Record of Updates and Amendments page.

Note that the versions of the manual released in 2010 (Amendment # 1) and 2017 (Amendment # 2) were issued as completely revised (or rebranded) manuals, whereas from 1 January 2021 the manual is being updated on a chapter-by-chapter basis, using Version #s to identify the new chapters.

Details of original issue and amendments of complete manual up until 1 January 2021:

Version #	Date issued	Document title
Original Issue (V1)	January 2007	Complete new NZ Hobby Car Manual
Amendment # 1	November 2010	Major revision of complete NZ Hobby Car Manual
Amendment # 2	July 2017	Re-branded as New Zealand Car Construction Manual

Details of chapter amendments after 1 January 2021:

Chapter #	Chapter title	Issue date	Effect date	Version #
Chapter 9	Engine & Drive-train	5 Feb 2021	1 Mar 2021	Version 3
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Update and Amendment Reference

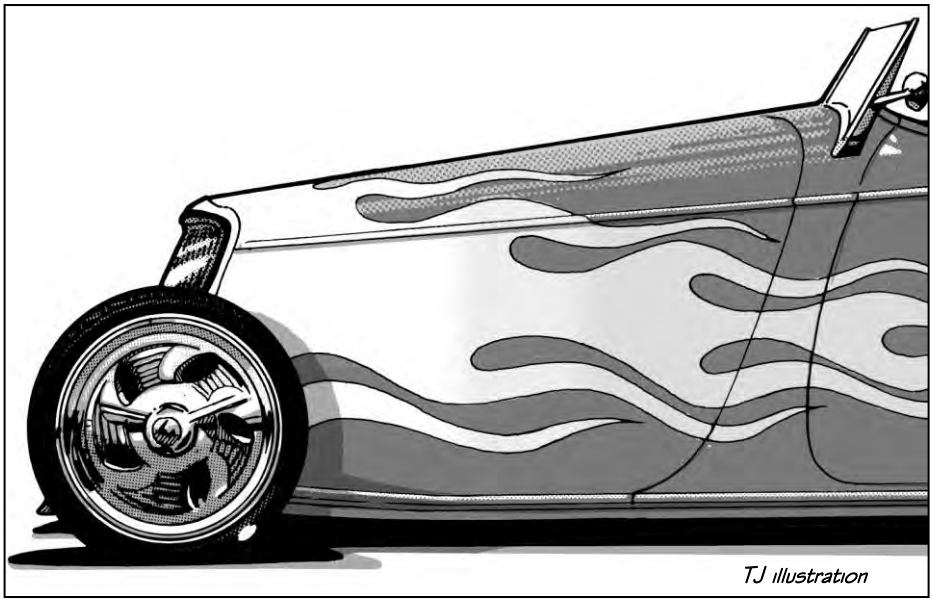
This Update and Amendment Reference page is provided to enable a manual-holder to quickly confirm that each chapter is in fact the correct Amendment #. To ensure that this Update and Amendment Reference page is current, it should be compared to the master Update and Amendment Reference page on the LVVTA website www.lvvta.org.nz

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A-1	Acknowledgement	November 2010	Version 2
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Chapter 1	Low Volume Vehicle System	November 2010	Version 2
Chapter 2	About This Manual	November 2010	Version 2
Chapter 3	Authority Card Process	November 2010	Version 2
Chapter 4	Build Approval Process	November 2010	Version 2
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Chapter 7	Steering Systems	November 2010	Version 2
Chapter 8	Braking Systems	November 2010	Version 2
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Chapter 15	Glazing & Vision	November 2010	Version 2
Chapter 16	Interior Equipment	November 2010	Version 2
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Chapter 18	Attachment Systems	November 2010	Version 2
Chapter 19	Vehicle Operation	November 2010	Version 2
T-1	Terms & Definitions	October 2010	Version 2
AA-1	About the Author	November 2010	Version 2

Chapter 1:

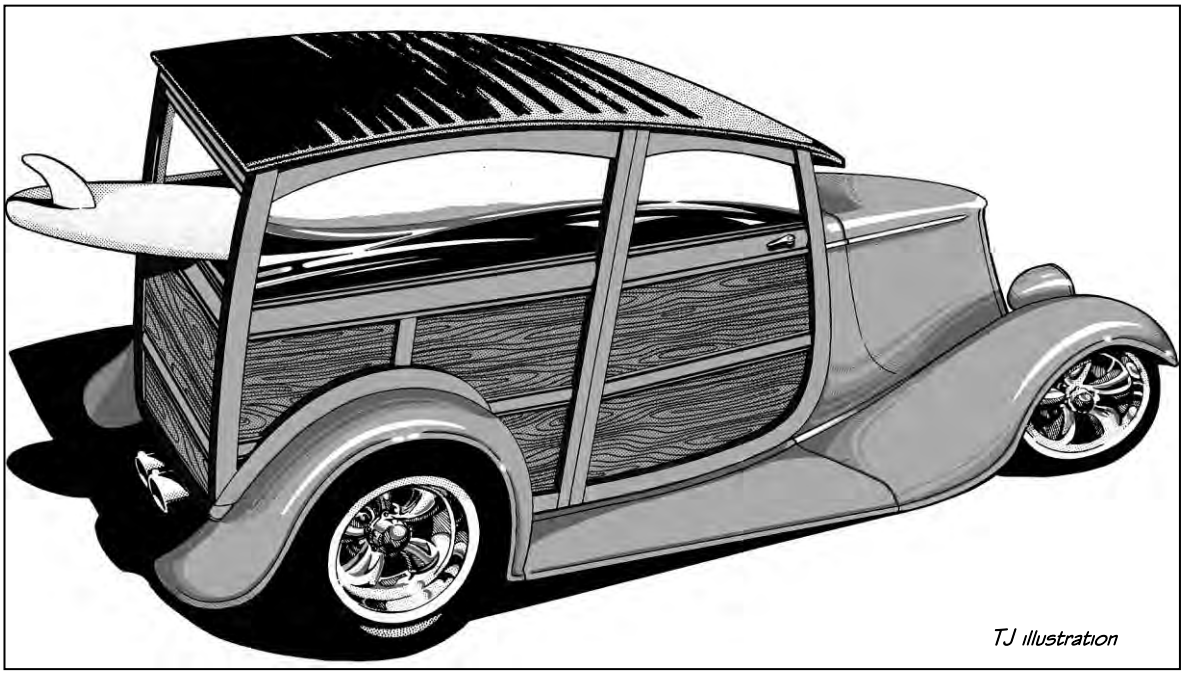
LOW VOLUME VEHICLE SYSTEM



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CHAPTER 1: LOW VOLUME VEHICLE SYSTEM

Introduction

Whilst this chapter won't help you build a better or safer car, it will give you the opportunity to learn the basic history and principles of the low volume vehicle certification system if you feel the need to know.

This chapter is intended to provide an overview of how the low volume vehicle system has evolved, and currently works in New Zealand. It outlines the various parts of New Zealand's overall legislative regime in relation to modified and scratch-built cars, and the relationships between the various organisations involved in the low volume vehicle certification system. It is hoped that this will help car builders gain a better understanding of why and how we have achieved the system we've got, and that some of the misunderstandings and misconceptions that surround the low volume vehicle system and certification process will be resolved as a result of reading the information in this chapter.

Evolution of the low volume vehicle system

1.1 Rumours of the new regulations:

The evolution of the low volume vehicle system in New Zealand started when the Government commenced planning the introduction of vehicle standards back in the mid to late 1980s. At that time, life for a hobby car enthusiast was a pretty simple affair. We could go down to the local post office, and register our new scratch-built hobby car - that may or may not have even existed at the time. And as long as our cobbled-together jalopy could pass a few simple warrant of fitness requirements at the local testing station, it was officially and legally 'on the road'. Aah, the good old days...

Vehicle standards-based safety regimes were by then already in place throughout most other western countries, and our Government's plans to introduce vehicle standards into New Zealand (despite wide-spread suspicion of it being some sinister sort of plot) was simply to drag New Zealand into line with the rest of the developed world, by introducing legislation to control the safety-related quality of vehicles imported into, and to a much lesser extent, manufactured in, New Zealand.

When rumours of this new Government legislation that was under development began to leak out, the New Zealand Hot Rod Association (Inc) (NZHRA) investigated what was going on, and learnt that the Ministry of Transport's then proposals for how modified and scratch-built vehicles would be handled under the new regime wasn't going to be a palatable outcome for the hobby car enthusiast.

1.2 Effects of the new regulations as proposed:

The new vehicle standards-based regulations as originally proposed by the Ministry of Transport would have meant the end of New Zealand hobby car enthusiasts building and modifying vehicles. Under the new regulations as they were originally drafted, it would have become illegal to build a vehicle, or to modify a component or system in a production vehicle governed by one of the new vehicle standards, unless the modification could be shown to comply with the standard, via the same level of testing that the component or system had experienced to gain initial approval. In most cases, that would have meant that the vehicle would have to be subjected to physical tests that are both complicated and expensive to carry out, and which would permanently damage the vehicle.

For the major vehicle manufacturers, this process is an accepted practice, as their massive investment in type testing vehicles and components to demonstrate compliance with a standard can be amortised out over the thousands of vehicles they sell. For Joe Home-builder however, it would have meant finding a new hobby.

After lobbying by NZHRA and other enthusiast groups, the Ministry recognised that there needed to be some relaxation introduced, rather than what would have effectively been a blanket ban on building and modifying motor vehicles. Their initial solution by which to resolve this problem was to adopt the rules that some parts of Australia had applied to modified and home-built vehicles (limiting modifications and/or capping distances that such vehicles could travel on public roads), and then use our local 'registered transport engineers' to do the safety-inspections.

From NZHRA's point of view, these engineers were probably very good at calculating the strength of a draw-bar on a truck, but as an industry, they knew nothing about the complexities of a scratch-built hot rod or sports car (nor should they be expected to, as that's not their area of expertise), and at costs of up to $1000 that NZHRA was hearing about just to certify a draw-bar, what was it going to cost us for a whole scratch-built hot rod? And, of even greater concern, what sort of outcome would result from an inspection made by someone who didn't know what he was looking at?

1.3 The low volume vehicle system solution:

After getting their heads around the issues at stake, and developing a relationship with the key Government officials, NZHRA proposed in 1990 that the Ministry allow NZHRA to write their own technical rules, use their own experts for the inspection process, and 'self-regulate'.

The Ministry, after been subjected to a considerable education process by NZHRA, and gaining a new appreciation for the upper end of hot rod design and construction along the way, eventually became satisfied that this could in fact be the way forward, and agreed in principle (with plenty of provisos) to NZHRA's proposed self-certification concept.

In order to legally empower this process, the first version of the 'Low Volume Vehicle Code' (LVV Code) was developed by the Ministry and the enthusiast groups that were involved at that stage, as an alternative standard approved under the Transport (Vehicle Standards) Regulations 1990 (VSRs). In effect, the LVV Code became a concession that could be used by hobby car builders and modifiers as a way through the new legislative regime.

To be eligible to use the LVV Code, the vehicle must be constructed in quantities of less than 200 per year by a manufacturer or constructor whose total production of any type of motor vehicle would not exceed this number, which effectively confined the use of the LVV Code to low-production kit car manufacturers, very small specialist vehicle manufacturers, and one-off home builders and modifiers.

It became recognised by the Ministry that with the level of historical knowledge (of both how, and how not to do things) and experience contained within the NZHRA network, that 'best practice solutions' could in fact become a very legitimate and successful means of operating an alternative system for scratch-built and modified vehicles, alongside the formal vehicle standards regime for production vehicles. It was agreed, then, that in general terms, the LVV Code would allow a vehicle to be built or modified and still comply with the new Transport (Vehicle Standards) Regulations 1990, by substituting the approved standards for high volume (mass-produced) vehicles, with an alternative method and procedure that captured the spirit of the original vehicle standards, but without having to resort to physical testing. These 'alternative standards' would become recognised as 'low volume vehicle standards', and would provide the technical requirements for modified and scratch-built vehicles, based not on physical testing and expensive calculation work, but on 'historical best-practice knowledge'.

1.4 The start of low volume vehicle certification:

As the start of 1992 rolled around, the LVV Code was written and incorporated into the new legislation, and NZHRA had written their code of practice (the original NZHRA Code of Construction Manual), established their administrative system, appointed their own certifiers, and were getting ready to commence LVV certification operations. The first two cars to be LVV certified in New Zealand were two brand new hot rods making their debut at the NZHRA Street Rod Nationals in Masterton, in April 1992.

Other enthusiast groups (the Sports Car Club of New Zealand, NZ Motor Caravan Association, and the Constructors Car Club) also gained approval to establish and operate their own parallel 'self-certification' systems.

Initially, like the other enthusiast groups, NZHRA were only concerned with their own members' vehicles, however it was only a matter of weeks before the Ministry of Transport came to NZHRA and one of the other groups, asking them if they could also look after all the other non-member vehicles out there, whose owners found themselves in the same situation as the enthusiast group members, with vehicles that were modified and suddenly required LVV certification.

The groups' operations expanded quickly, by being tasked with looking after suspension modifications, brake adaptations, diesel engine conversions, and all sorts of other more mainstream modifications, in addition to their own members' hobby vehicles.

1.5 Establishment of the Low Volume Vehicle Technical Association:

Also during 1992, the six organisations then involved in some way with the new-born LVV certification system (not all of them were actually operating LVV certification systems), formed the Low Volume Vehicle Technical Association Incorporated (LVVTA), as a parent body to represent the interests of those six groups, and to produce the LVV certification plates for the groups carrying out LVV certification operations.

By the mid-1990s, then with eight member associations (and effectively representing all of the other non-member enthusiasts in New Zealand), LVVTA had taken on the role of dealing with the Government directly on behalf of all of their member groups - rather than each group individually knocking on the Ministry's door as had initially been happening - and was having a positive effect on the overall LVV certification system. The individual certifying member associations like NZHRA could then worry less about the politics, and get on with looking after their certification operations.

1.6 The single-certification system merger:

After a couple of years of operation, it had become apparent that the quality of inspections varied between the groups, and that the inspection quality wasn't ever going to become uniform while individual groups operated their own systems, and developed their own individual interpretations of the Government's vehicle standards. To resolve this, the development and implementation of a unified single-certification system, and commonised 'alternative standards', was agreed upon by the member associations of LVVTA.

In 1995 LVVTA took on the role of merging the systems into one, under LVVTA's administrative control. NZHRA had been doing around 70% of all of the LVV certification work since 1992, and their system was by far the most advanced and comprehensive, particularly from an inspection quality point of view. The single-certification system therefore became based primarily around NZHRA's systems and documentation, and was up and running in 1996.

At the same time, the Ministry of Transport's by then new arm, the Land Transport Safety Authority (now known as the New Zealand Transport Agency) took over the responsibility for appointing and revoking the individual LVV certifiers (until then the responsibility of the LVVTA member associations), along with the independent auditing of the quality of the LVV Certifiers' work.

1.7 The low volume vehicle system today:

Since the merging of the systems in 1996, the LVV certification system has, amidst a few ups and downs, been improved and refined enormously, with the development of a selection of low volume vehicle standards which set technical requirements to cover a wide range of safety-related systems and modifications.

These range from all of the typical performance enhancement type of modifications (engine conversions, brakes, suspension, wheels, etc) to seat installations, seatbelt anchorage retro-fitting, right-hand drive steering conversions, removal and disabling of supplementary restraint system air-bags, security modifications for security vans, through to adaptive control systems for people with disabilities, and designing modifications to remedy factory faults in production vehicles.

The LVVTA system, now with ten LVVTA member associations supporting it, has over the past decade expanded beyond just low volume vehicle standards, and now encompasses form-sets, information sheets, and other supporting documentation. The LVVTA documentation system is now so extensive that it fills an 8-volume set of manuals. A substantial chunk of the technical expertise and input behind all of this has in fact come from hot rodders – mostly NZHRA members - who still today continue to contribute a massive wealth of technical input into the LVVTA knowledge pool.

The vast majority of the 60 LVV Certifiers around the country are the practical hands-on hobbyists who have spent their lives building and modifying cars, making mistakes and learning from them, amassing knowledge from the car club scene, and furthering their knowledge even beyond that through the engineering side of the motor racing environment.

Amongst these LVV Certifiers, who largely come from a hot rodding background, are national championship winners from the Dunlop Targa, the Muscle Car series, the Pre-'65 Saloon Car series, Clubmans racing, Off-road racing series, and there are national record-holders and championship winners in the national drag racing series. Also within the LVV certifier network is a world land speed record holder, a sports car manufacturer, a kit car designer and builder, a 6-second 200 mph dragster driver and tuner, along with numerous award-winning hot rod fabricators, and people that build, engineer, and wrench on everything from dragsters to circuit cars, to tarmac rally cars.

Most of these guys started their LVV certification involvement right at the inception of the LVV system in 1992, and are utterly irreplaceable; - there is no degree, trade, profession, poly-tech, night-school, or text-books that can equip someone without the life-time of first-hand knowledge and experience that these people have – these practical hobbyist-based LVV Certifiers are graduates, with honours, from the real-world university of a car-building life, and from a decade or more of assessing, and learning from, the many and varied vehicles they inspect in their LVV certification role. Without them, the system would collapse. We must all – hobbyists and Government officials alike - respect them and value them enormously, and at the same time keep an eye toward the next generation of LVV certifiers, who are now quietly doing their hobby car building 'time', in their home-garages in every corner of the country.

1.8 The future of the low volume vehicle system:

The job however, is far from over. There is still a mountain of work to do, because time, trends, and technology never stand still, especially in the world of modified and scratch-built vehicles – where everyone is trying to do something that is just that little bit different to everyone else. There are still many technical standards needed and yet to be completed, and there are a host of other components and systems that all need safety-related technical requirements put in place to ensure that whilst we are able to maintain our traditional freedoms to modify and build cars, we do so whilst incorporating the highest levels of safety that can be practically achieved.

Our challenge, however, is to achieve this within a general legislative environment that is increasingly safety-conscious, heavily regulated, environmentally paranoid, and politically correct - no, - make that politically over-the-top. No matter how diligent we are, how seriously we take our responsibilities, and how well we do our job, managing our situation within this 'Nana-state' will always be our biggest challenge; – even now, as I write the final pieces for this manual from the tranquility of Hopewell Lodge, my favourite back-packer retreat in a remote part of the Marlborough Sounds, our hosts are, because of stringent and unbending council regulations, busy building a massively expensive wheelchair ramp into their recently extended communal cooking facility – never mind that the only way to get to this isolated spot is by boat, and there's not a room nor an ablution block anywhere in the sixty year old complex that can be accessed from a wheelchair…

About the Low Volume Vehicle Technical Association

1.9 Horses for courses:

LVVTA is an incorporated society, and comprises ten member associations, most of whom are hobbyist groups which would be adversely affected by motor vehicle legislation enacted without their interests being represented during the development process. The member associations are: the New Zealand Hot Rod Association, MotorSport New Zealand, Sports Car Club of New Zealand, Constructors' Car Club, Vehicle Association of New Zealand for People with Disabilities, New Zealand Motor Caravan Association, Component Car Manufacturers Association of New Zealand, New Zealand Four Wheel Drive Association, Vintage Car Club of New Zealand, and Kiwi Trikers Social Club.

The net result for the hobby car enthusiast because of LVVTA's operations, is that the technical requirements relating to vehicle modification and construction are, considering the over-regulated environment we live in, workable and achievable from a practical point of view. Builders can work to the rules, and LVV Certifiers can apply the rules.

The reason for the level of success in the LVV system in New Zealand is down to one simple factor – the rules are written for enthusiasts, by enthusiasts. In most other countries, regulations for modified and scratch-built vehicles are written by their government, rather than by representatives of the enthusiasts, and the outcome of that is always, as far as we are aware, unsatisfactory for both parties. This is no criticism of those governments – just recognition that no one group can be expert in all areas; – just as LVVTA or NZHRA could not be expected to be experts in rules relating to motor body repair rules or certificate of fitness requirements, the government departments responsible for overseeing the country's entire motor vehicle certification regime cannot be expected to be experts in a specialist area as small and complex as modified and scratch-built vehicles.

1.10 Do as they do, not just as they say:

Despite any (real or perceived) shortcomings of the LVV system, the New Zealand hobby car community is very fortunate to be in a position where people from within their own ranks are responsible for writing the technical requirements by which our vehicles must be built. Within the home-garages of the six full-time LVVTA team members, there is a 1928 Model-A Roadster hot rod, a 1968 Corvette Roadster, a 1959 Cadillac, a circuit-car, an 8-second 1956 Chevy drag car, a 6-second Ford Customline drag car, a 1955 Pontiac Safari, an Almac Sabre kit car, a modified big block Chevy Pick-up, and two modern V8 daily drivers. Only one of the six LVVTA people own only 'normal' cars!

Likewise, the home garages of the LVVTA Management Committee members include a home-built special, a historic racing car, some old English motorcycles, various sports cars, a Harley Davidson, and a couple of hot rods.

Statistics like this are the best chance for a healthy future for the car building and modifying hobby – almost every time the LVV system faces a problem, the cause of it comes from someone (within or outside of the Government) who has neither understanding nor empathy for the modified or home-built car, or its owner – and it must be virtually impossible for regulators to understand our passion or see things from our perspective, when, in some cases they don't own a motor vehicle, or even hold a drivers' licence.

Relationship between the law and this manual

1.11 Land Transport Rules:

All safety-related motor vehicle requirements, and all of the national certification processes are governed by the Ministry of Transport's Land Transport Vehicle Compliance Rule. Everything we, as New Zealand citizens, and as players within the motor vehicle industry or hobby, can and cannot do in relation to motor vehicles, is governed by this Rule.

In addition to the Land Transport Compliance Rule, the Ministry of Transport has a number of individual 'equipment rules', which specify legal requirements for all vehicles for selected components and systems.

1.12 Low Volume Vehicle Code:

Within the Land Transport Compliance Rule, it is specified that any vehicle, that because of its origin or modifications becomes a low volume vehicle, must be certified to the Low Volume Vehicle Code of the Low Volume Vehicle Technical Association Incorporated.

The LVV Code is a document agreed between the LVVTA and the Government that sets out the legal framework for how modified and scratch-built vehicles in New Zealand are to be treated. The LVV Code is owned and administered by the LVVTA, and is amended from time to time as required, in consultation with, and with approval from, the New Zealand Transport Agency.

The individual equipment rules also, where appropriate, refer in turn to the 'Low Volume Vehicle Code of the Low Volume Vehicle Technical Association Incorporated', in the case of a vehicle that is modified or scratch-built.

1.13 Low volume vehicle standards:

Within the LVV Code, the low volume vehicle standards are legally empowered. Although developed and written by the LVVTA, these must be approved and signed off by the Government.

The starting point for the LVV Standards comes from LVVTA researching and interpreting the relevant overseas vehicle standards that apply to mass-produced vehicles. With a lot of technical input from NZHRA, the LVVTA Technical Advisory Committee blends in the car hobby's immense historical knowledge and best-practice methodology associated with the subject of the standard under development. From that point, the LVVTA develops a practically-oriented 'alternative standard', written in such a way that it can be implemented without destructive testing or prohibitive analysis costs, while still capturing the basic intent and spirit of the international vehicle standards that are applied by the high-volume (mass-produced) vehicle manufacturers.

As time goes by, new vehicle standards will be introduced by the Government, and for as long as the good relationship that exists today between LVVTA and the Government continues, LVVTA, with NZHRA's on-going technical support, will continue to develop 'alternative standards' for each new main-stream vehicle standard that is introduced.

The low volume vehicle standards however, don't always cover the level of complexity found within a scratch-built hobby car. The low volume vehicle standard for suspension systems (at 12 pages long), for example, is a technical standard that covers common suspension modifications, such as that which you'd find in the lowered performance imports which LVV Certifiers are assessing every day of the week, all around the country. This suspension standard however, doesn't go anywhere near the complexities of the suspension issues within scratch-built vehicles, such as custom independent front suspensions, modified beam axles, aftermarket tubular axles, and so on – which whilst high in complexity, is very low in the numbers of vehicles that it applies to. This is because the LVVTA documentation system has to focus on providing technical requirements for the modifications that constitute the majority of the LVV certification work.

1.14 NZ Car Construction Manual:

Therefore, there is a need for a document such as the old NZHRA Code of Construction Manual, or now, the new NZ Car Construction Manual. The Car Construction Manual takes over from where the relevant low volume vehicle standard finishes.

NZHRA's initial development of the NZ Hobby Car Technical Manual (now called the Car Construction Manual) has enabled LVVTA to focus on the wide and varied commercial pressures it faces, and allowed the appropriate specialist LVVTA member associations to focus in on the specialist areas relative to their membership's needs. Far better for the experts to say that "yes, you can drill your old Ford I-beam axle provided that…", than for NZHRA to do nothing, with the result that someone else takes the safer ground in the absence of the necessary knowledge, and says "no, you can't drill your old Ford I-beam axle".

The Car Construction Manual is referred to in most low volume vehicle standards, as being the applicable source of information and requirements, where the nature of the modification or construction on the vehicle in question is beyond the scope of the standard.

The Car Construction Manual, therefore, forms an essential and integral part of New Zealand's LVV certification system, and in order to 'lock in' the Manual into New Zealand's regulatory framework, LVVTA purchased the Manual from NZHRA during 2010. NZHRA will continue to have a high degree of input into any future additions and improvements to it.

Low volume vehicle principles and procedures

1.15 Procedure for getting a new hobby car on the road:

There are two separate aspects to getting a new hobby car on the road; - the process of meeting the new 'entry compliance' requirements ('entry' meaning entry into the NZ vehicle fleet), and the process of ensuring that the vehicle is safe.

In order to meet New Zealand's entry compliance requirements, it has to be demonstrated to a Transport Service Delivery Agent ('TSDAs' are VINZ, VTNZ, AA and On-Road) that you have 'entitlement' to the vehicle (legal ownership), and that the vehicle, if imported, arrived through the correct and legal channels. A new scratch-built vehicle is quite straight-forward in this regard.

In order to show that the vehicle is safe, it has to undergo low volume vehicle certification. The LVV certification process accounts for 99% of the vehicle's safety inspection, however, the TSDA will still carry out a basic check-over, mostly from a warrant of fitness viewpoint.

The correct order of steps required in order to get a new scratch-built car legally on the road are as follows:

- Utilise a suitably skilled and experienced LVV Certifier to carry out the preliminary inspections as the car progresses (a list of NZHRA-endorsed LVV Certifiers is available from NZHRA's website – www.hotrod.org.nz).

- When the car is nearing completion and its final LVV certification inspection, go to a TSDA and have a Vehicle Identification Number (VIN) allocated. This is a 17-digit number that any vehicle entering or re-entering the national vehicle fleet must have. The VIN must be allocated before the LVV Certifier can do his final inspection and order the LVV certification plate, as the vehicle's VIN has to be recorded on the LVV certification plate. The TSDA may or may not need to see the vehicle before allocating a VIN.

- The LVV Certifier can then carry out his final LVV certification inspection. At this point, he will need to be provided with any supporting documentation that he may require, such as NDT reports, wheel alignment reports, etc. When the LVV Certifier is happy, he will order the LVV certification plate, which, upon its arrival to him, he will affix to the vehicle structure. If an LVV Authority Card is required, follow the procedure specified in 'Chapter 3 – Authority Card Process'.

- The vehicle owner then takes the vehicle, with LVV certification plate fitted, to the TSDA. The TSDA will do his safety check and (if it passes) issue a warrant of fitness, generate the form from which the registration plates and label can be issued, and can then supply and affix the registration plates and label. The vehicle is then legally on the road.

For a new scratch-built vehicle, as long as the steps are followed, it's actually a reasonably straight-forward process, with a minimum of backward and forward movements.

1.16 Scratch-built vs Modified Production:

It is important to correctly distinguish between a 'modified production low volume vehicle', and a 'scratch-built low volume vehicle'. This is because the LVV certification requirements that they have to meet are very different.

A modified production low volume vehicle must comply only with those applicable technical requirements that might be affected as a result of the modifications that have been carried out. For example, a 1957 Chevy that has had a late-model 350 and over-drive automatic transmission fitted (and is otherwise original) only has to meet the applicable requirements specified for an engine and drive-train conversion in 'Chapter 9 – Engine & Drive-train', and because the vehicle's increased performance is likely to have an effect on the vehicle's braking performance, it also has to meet the requirements relating to braking performance specified in 'Chapter 8 – Braking Systems'.

For a modified production low volume vehicle, no other specific chapters have to be complied with, although under the LVV Code, the whole vehicle must be checked over for general safety, and to make sure that any modification or group of modifications has not had a wider effect on the overall safe operation of the vehicle.

A scratch-built low volume vehicle however, must comply with all applicable technical low volume vehicle requirements, which include every technical section in this Car Construction Manual, from 'Chapter 5 – Chassis Modification & Construction' through to and including 'Chapter 19 – Vehicle Operation'.

1.17 Vehicles built or modified before 1992:

Some vehicles built or modified before the introduction of the new vehicle standards regulations were issued with what is known as a 'modification declaration certificate'. This is a form that effectively shows to any warrant of fitness issuer that 'this vehicle was built or modified before the new regulations came in, therefore it is not required to be LVV certified'.

This form remains good for the life of the vehicle, provided that; one – the vehicle hasn't been modified further since the modification declaration certificate was issued; and two – the vehicle's registration doesn't lapse. If the vehicle is modified beyond that which is stated on the modification declaration certificate, or the vehicle's registration lapses, the vehicle must then be LVV certified.

As is always the case, the LVV certification process will apply to the vehicle in its entirety (not just the new modifications), however the date upon which the vehicle was built or the majority of modifications were made will be taken into account, with a different set of requirements applied by the certifier, than if the vehicle was brand new. A scratch-built hot rod constructed in the 1980s with a single-circuit master cylinder, for example, will not be required to be upgraded to a dual-circuit master cylinder (as is required for a new scratch-built vehicle built after 1992) just because the registration lapsed, or because the Mk 3 Zephyr front discs (fitted when the car was built) are changed to some later model HZ Holden front discs after 1992. Common sense does still prevail within most areas of the LVV system.

In the same way, someone immigrating to New Zealand from overseas who brings their scratch-built kit car that was built before 1992, will, provided documented evidence is available to prove that it was in fact built prior to 1992, will not be required to comply with all of the new safety standards introduced after 1992, such as door retention systems and steering system collapsibility.

All vehicles however, irrespective of when they were built, or where they have come from, will be required by the LVV Certifier to be safe to operate, especially from a steering/suspension/braking point of view.

A copy of the modification declaration certificates issued during the early to mid 1990s are held by LVVTA, a duplicate of which can be purchased in the event of a vehicle owner losing his or her original modification declaration certificate. Note that in most cases, the testing stations that issued them did not file a copy at the time of issue (as was intended by the Ministry of Transport), so a duplicate won't be able to be provided. However, a copy of any modification declaration certificates issued by an NZHRA certifier will almost certainly be on file. You can find out how to access this service by going to LVVTA's website, www.lvvta.org.nz.

Government legislation background

1.18 Early New Zealand transport legislation:

Motor vehicles in New Zealand have traditionally been governed by a set of rules that have been around since the 1950's, changed a little from time to time, and reviewed in the mid-1970's to become what we've known as the '1976 Traffic Regulations'. Until the early 1990s, these formed the basis of our Warrant of Fitness requirements.

Prior to 1990, many overseas-manufactured vehicles had been imported into New Zealand with certain components falling below an acceptable standard, in particular, windscreen glass and seatbelts, and in many cases vehicles were being imported that had no rear seatbelts fitted at all, at a time where all vehicles of such age should have had them fitted. There also needed to be a regime to stop the importation and sale of various non-approved components, including lights and lenses which didn't meet any standard because their sub-standard manufacturing processes provided no ultra-violet resistance, and after short periods of exposure to sunlight, the red lenses had turned white.

'Vehicle standards' have been an integral part of the motor vehicle industry for decades in most other western countries, and it was inevitable that eventually those responsible for controlling vehicle safety in New Zealand would identify and adopt suitable internationally recognized overseas standards for New Zealand.

1.19 Introduction of vehicle standards:

The Transport (Vehicle Standards) Regulations 1990, (VSRs), began to apply from 1 November 1990, but took real effect in the industry in 1992. The VSRs prescribed internationally established automotive standards for key items that affect vehicle safety, such as seatbelts, their anchorages, glazing, and lighting equipment. They require specified components and systems to comply with a standard, and to be maintained in accordance with the standard throughout the life of the vehicle.

If a component covered by one of these standards was to be repaired, the repair must have restored the component to its original condition as specified by the standards. This requirement is vital to the overall integrity of the vehicle standards philosophy, as any safety feature or device is only as good as its ability to continue to function correctly. It would be pointless having safety-related standards for new and imported vehicles only to allow these standards to become ineffective as soon as the vehicle is repaired.

Whereas the old 1976 Traffic Regulations just said that our vehicles must have four tyres with some tread on them, the new Transport (Vehicle Standards) Regulations 1990 said that whatever tyres we use on our vehicle (in addition to having sufficient tread on them), they must also have specific markings to prove that the carcass construction, load rating, speed rating, and method of manufacture all comply with one or more internationally recognized safety standards, and are therefore assured of being of good quality - as opposed to some tyres available in some parts of the world that are poorly made and create a potential danger to all road users.

Looking at it simplistically, the '76 Traffic Regulations are an old group of rules that tell us what items our vehicles must have, whereas the Transport (Vehicle Standards) Regulations 1990 were the 'new-wave' type of legislation that told us exactly which of all of those items that are available, we are able to put on our vehicles.

The implementation of vehicle standards within our motor vehicle industry forced our New Zealand assemblers and manufacturers to use only approved components where there was a requirement for compliance, although more importantly, the regime also assured that any vehicles imported into New Zealand (particularly used imports) met the same safety requirements.

The introduction of the Transport (Vehicle Standards) Regulations 1990 is what made the whole Low Volume Vehicle Code, the self-certification regime, the original Code of Construction Manual, and now this new Car Construction Manual necessary.

1.20 The new 'Rules' regime:

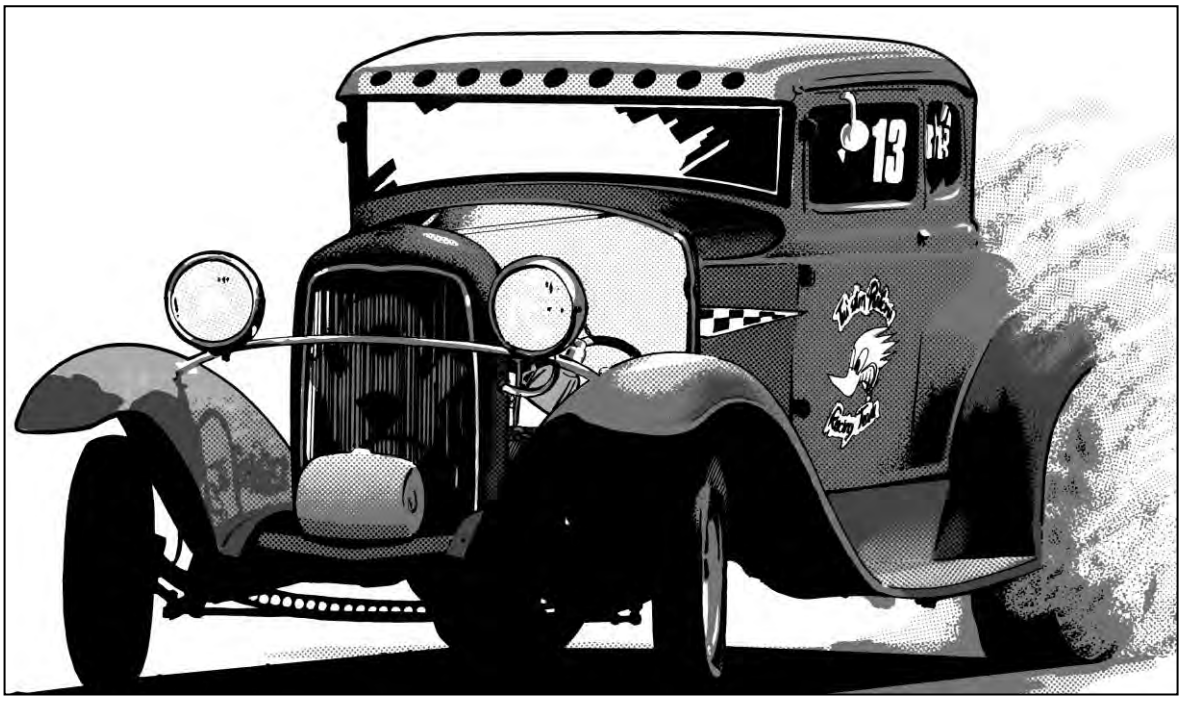
The years of 1990 through to 2005 have been an extremely messy period for motor vehicle legislation in New Zealand. It was very simple before then, and will probably never get as complex again. Only a few years after the Transport (Vehicle Standards) Regulations 1990 (VSRs) were introduced as an addition to the 1976 Traffic Regulations, development began on the new 'Land Transport Rules' regime. The idea of the Rules regime was to improve the VSRs, and amalgamate the VSRs with the 1976 Traffic Regulations.

For the industry, it's been a head-spinning period trying to cope with a combination of Traffic Regulations, Vehicle Standards, and Land Transport Rules, which have kept constantly changing. Now, half-way through the first decade of the 21st century, the Government has almost completed the huge job of integrating New Zealand's transport legislation into one standardised 'Rules' regime.

Things should, we hope, become much easier from here-on. Having said that, safety technology is becoming more and more complex, such as supplementary restraint system airbags in steering wheels, seats, and the body structure, along with traction control, stability control, and anti-lock braking systems. This technology is all moving forward at an astonishing rate.

For all of the variations of modern safety technology, there is a low volume implication, and the LVV system has to keep pace with it all.

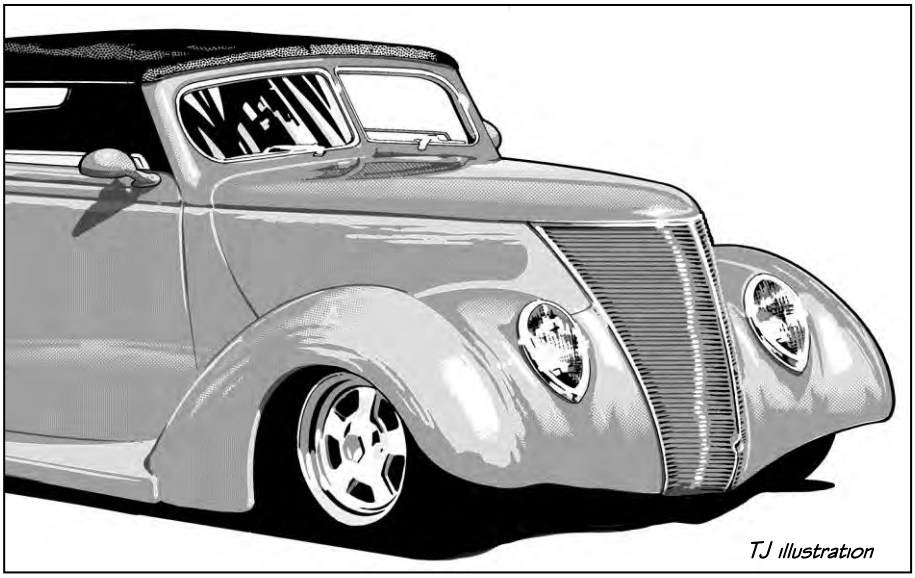
There really is a lot to be said for carburetors, points ignition, and I-beam axles – I wonder if past LVV Certifier Gary (Grease) Martin was right many years ago when he said *"...overhead valve engines are just a passing fad..."*



TJ illustration

Chapter 2:

ABOUT THIS MANUAL



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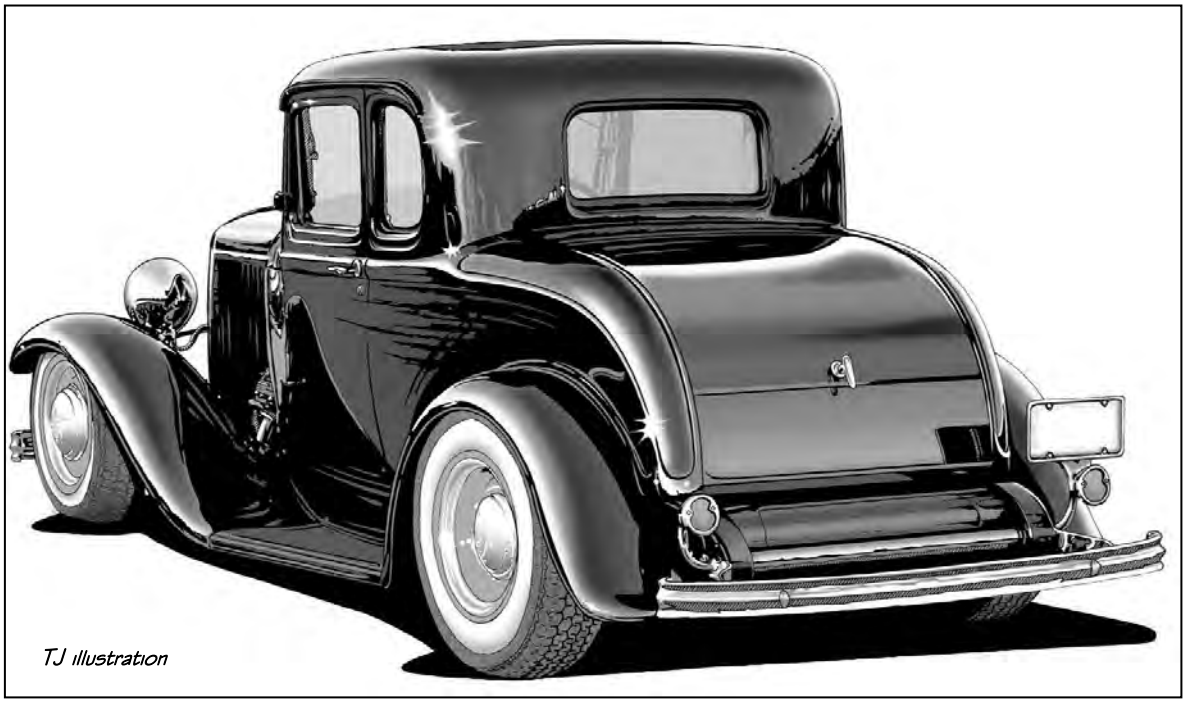
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TJ illustration

CHAPTER 2: ABOUT THIS MANUAL

Introduction

There's nothing technical in this chapter – the technical stuff starts at Chapter 5 – but this chapter is still worth a read. This chapter provides some useful bits and pieces of information, aimed at helping you to use this Car Construction Manual, and get through the LVV certification process with the least amount of stress possible.

By reading this chapter, it should help to make the manual look a bit smaller, and make it easier for you to find what you're looking for.

What this manual contains:

2.1 Strong technical focus

Firstly, let's quickly cover what the manual *doesn't* contain. Unlike the old 1992 Code of Construction Manual, there is very little procedural information within this manual. The old Code of Construction had to contain a lot of peripheral information about the LVV systems, procedures, and administrative information, because back then, that book was effectively the whole system.

Since then things have changed considerably. The LVVTA has taken over all of that side of things, and the 8-volume LVV Certification Manual sets out how all of that side of the system works. This information is all well known to your LVV Certifier, and he can guide you through this side of things when you need to know.

This means that the new Car Construction Manual can focus on just that – technical information that will help you to build a car that will eventuate into something that will be well engineered, safe, good to drive and ride in, and be more reliable. The new manual has somewhere in the region of 6 times the quantity of technical information compared to that contained in the old Code of Construction, and the information provided is better detailed, set out more clearly, and will withstand legal scrutiny much better than its predecessor.

The only non-technical information in the manual is 'Chapters 3 – Authority Card' and 'Chapter 4 – Build Approval Process', which have to be specified here, because they are NZHRA systems.

2.2 Philosophy of this manual

This new Car Construction Manual is effectively the sum of three simple ingredients; one - the old 1992 NZHRA Code of Construction Manual; two - the answers to all (or most, anyway) of the hundreds of questions not covered by the Code of Construction Manual that have been raised during the last 18 years; and three – the experiences and knowledge built up and passed back to us by the LVV Certifiers, Technical Advisory Committee members, and hobby car guys building cars since LVV certification began. "Can I use tie-rod ends to secure my radius rods to my chassis?" "Can I drill my old Ford I-beam axle?" "Will I be able to weld up my chassis myself?" "What size tubing should I use for my custom IFS A-arms?"

So, in effect, this manual is not a great big list of things that you can't do, but is in fact a great big list of things that you can do - provided of course certain safety-related requirements are met. "Yes, you can use tie-rod ends to attach your radius rods, provided that..." "Yes, you can drill your I-beam axle, provided that..." "Yes, you can weld up your chassis yourself, provided that..." And so on.

Remember too, that the manual is not set in stone – it will be amended and improved as time goes by, and as new things and better ways of doing things are learnt. A 'living document', as they say. The way that the chapters and page numbering within each chapter have been designed allows for on-going amendments, through individual page or chapter replacements, without messing up the page numbering of the whole manual. Because of the manual's design and format, it is expected to have a very long life.

Tips for using this manual:

2.3 Its not as big as it looks

Don't panic about the size of this manual! Yes, there are a lot of technical requirements in it, but you have to realise that they won't all apply to your car. Your car won't, for example, have a I-beam front axle, and a tube front axle, and a production vehicle independent front suspension, and a custom-built independent front suspension – the manual is designed to cover all of the common different types of components and systems that might apply to your project, but no one vehicle will be using them all.

The first thing you might like to do is to make the manual less daunting, by taking a pencil, and running a pencil line down the middle of each section in each chapter that won't apply to you. You'll then be able to focus on just the parts of the manual that apply to your vehicle, which will have the effect of making the manual suddenly look a whole lot smaller and simpler than when you first looked at it!

2.4 Easy to use format

Hopefully, you'll find the format of the manual easy to follow and use. The 2/3 page sections of Chapter 5-on (the technical stuff) sets out the technical requirements, whereas the 1/3 margin on the right hand side is not requirements, but helpful information. In the 1/3 margin, next to the relevant technical requirements, you'll find helpful comments, explanations, clarifications, interpretations, references, and tips, all of which are designed to enable you to better understand what the relevant technical requirements are getting at.

Don't forget to use the contents pages at the start of each chapter – lots of effort has gone into making it easy for you to find whatever it is that you're looking for. Want to know about how much front-end caster you should be running? That's a steering geometry subject, so go to 'Chapter 7 – Steering Systems'. Then scan down the Chapter 7 contents pages until you find the bold heading 'Steering system geometry requirements'. Then scan down that group of sub-headings until you find 'Caster angle geometry' – there it is - sub-section 7.34, on page 7-27. Easy!

2.5 How to protect the pages

Chances are, this Car Construction Manual is going to spend most of its life in your garage. And chances are that you'll be using it the most when you're up to your elbows in oil. You know what your manual is going to look like by the time you've finished that car!

The best way to protect any document like this is to slip each page into a clear plastic sleeve. Because the manual is ring-bound, doing this is dead easy. There are clear plastic sleeves that you can buy from any stationery shop, designed specifically for this situation – A4 pages in a ring-binder. They come in boxes of 100 (so you'll need 3 boxes), and they cost inside $10 per box. It's a little bit of initial outlay, but they'll keep the pages of your manual clean and legible, and there's the added bonus that your pages will never tear where they go through the rings.

It'll take a bit of time, so that makes it the ideal job for when your kids need a bit of payback.

2.6 Using the key

Within this manual, you will find some different type-faces. Most of the manual is written in a 'normal type', like that which you are reading right now. However, there are a couple of situations where you'll find different text, and it helps to be aware of this.

In other parts of the manual, immediately after a technical requirement, you'll see information provided as normal type in a square shaded box. These are referred to as 'retro-boxes'. Retro-boxes are intended to provide a softening of the technical requirement that they relate to, for in the case of a vehicle that was modified or built before a certain date. This retro-box concept effectively replaces the old 'Retrospective Code of Practice' in the old NZHRA Code of Construction Manual, for pre-1992 vehicles.

In some chapters of the manual, you'll see *'italic type',* which denotes that the information in that *italic type* is lifted from the relevant LVVTA low volume vehicle standard. These excerpts have been made available with permission from the LVVTA, in order to save readers of this manual from having to go elsewhere for more information. Except for very occasional circumstances, everything you'll need to know in relation to building or modifying a car is right here, in this 'one-stop' book.

You'll also see a lot of '*script type*', mostly in the right-hand side 1/3 margins, and in the 'Useful Information' section at the back of each chapter. Anything in *script type* is there just to try and clarify things for you.

Lastly, you'll see the occasional bit of shaded text with a vertical dotted line in the adjacent left-side margin. This shows you the bits that have been amended since the previous version.

To remind readers of these type-face distinctions, a 'key' (in a rectangular box) is provided at the end of the contents section of each chapter, in chapters 3 to 19.

2.7 The illustrations in this manual

The cars illustrated throughout this manual come from all corners of the automotive arena, but they all share a common thread; - they exist because of the ingenuity, creativity, and artistic skills of a rare breed of people who are innately brilliant with their hands, and are massively passionate about unique and special cars.

The hot rods and street machines, which range from resto-rod to radical, in most cases are cars that could still be legally built and driven in New Zealand. In fact most of them were built by Kiwis, who include some of our past and current LVV Certifiers, some past and current TAC members, some past and current NZHRA committee members and Presidents of NZHRA, and an LVVTA Management Committee member. These fantastic New Zealand-built cars each represent a great engineering achievement, and are shown throughout this manual as a small tribute to our clever amateur home-builders and brilliant professional fabricators alike.

Why the race cars? Because there's a kiwi hobby car-building connection with all of them. The drag cars are nearly all New Zealand-built, and if not, they're NZ national championship winners and record-setters. The origins of the circuit cars go back to great New Zealand car-builders like Graham McRae (the Formula 5000 car), and undoubtedly the most successful New Zealand hobby car builder ever – the late great Bruce McLaren. Bruce's race-car building and motor racing career started out no differently to the rest of us; - modifying his road cars in his home garage to find more speed (the Austin Seven special and the Austin Healey), armed with little more than the same intuitive and instinctive engineering and fabrication ability that is shared by many Kiwi hobby car builders. Bruce took that gift and went on to become one of only four men in the world ever to win a Formula One race in a car of his own making.

Things you need to know:

2.8 Before you start building

Before starting down the track of building a hobby car, there are two things that a builder needs to thoroughly consider.

The first thing is to decide whether or not to make use of the design approval process specified in 'Chapter 4 – Build Approval Process'. Although this isn't a mandatory process, it's highly recommended for the novice builder, or a builder that is departing from conventional or traditional ideas, and is building something radically different to the norm.

Even more important than deciding whether or not to make use of the build approval process, any car builder - whether novice or experienced, conventional build methods or radical - needs to form a relationship with the LVV Certifier that he or she will use throughout the vehicle's construction process, at the earliest stage possible.

It's essential to use an LVV Certifier that has had a lifetime of hands-on practical car building experience, and has been an LVV Certifier for a long time. Your best chance of ensuring this is to use an NZHRA-endorsed LVV Certifier, which can be found on the NZHRA website, www.hotrod.org.nz. This will maximise your chances of getting the correct interpretations of the requirements, and an LVV Certifier with the right background and experience will save you time and money, and give you a better riding and driving vehicle at the end.

On a project as expensive and time-consuming as building a car from scratch, you need to make sure that you're in the best hands possible, from the point of view of getting the car safely and legally on the road in the most cost-effective, stress-free manner possible. It could even be more important than selecting the right camshaft or intake manifold!

Make sure you do your homework and establish who your LVV certifier is going to be, and get a relationship going as early as you can – preferably before you buy the steel for the chassis.

2.9 What the LVV certification process might cost

The costs for LVV certification will vary depending on a number of factors. It is up to the LVV Certifier to charge as he sees fit, based on a reasonable hourly rate for his professional services. The greater the extent of the modifications or construction features, and the more problems within a vehicle to identify and advise on, the more time a certifier will have to put in, and the costs will increase accordingly.

Bear in mind that the time the LVV Certifier physically spends inspecting your vehicle, is not the sum total of his input. He has a considerable amount of documentation to create, collate, and prepare, and there are costs that he incurs for having the LVV certification plate manufactured, along with form-sets, courier bags, and phone calls.

He may spend time getting advice or an opinion from LVVTA or another LVV Certifier. He has a lot of non-chargeable time that he has to incur, a portion of which he has to cover within each LVV certification, including becoming and remaining familiar with the LVV Standards, Form-sets, Information Sheets, and other documents within the LVV certification system, and he has to attend LVVTA training sessions at least twice yearly.

He is required to undergo periodic auditing from the New Zealand Transport Agency (at a cost of several hundred dollars a time), and spend time maintaining his New Zealand Transport Agency auditing system. He also has to carry expensive professional indemnity insurance.

Generally speaking, despite all of the costs and work that a LVV certifier is subjected to in order to keep his authority, and the time he spends doing the certification on your vehicle, the LVV certification process (which makes the difference between getting your project on the road or not) will still cost you less than what you paid for that new 650 cfm double-pumper Holley - and as a bonus, your LVV certifier's expertise and experience is likely to help you to end up with a car that is not only safe, but drives well, and is reliable.

Problems and improvements:

2.10 Dispensations to the technical requirements

The Technical Advisory Committee (TAC) has a number of roles. It reviews and comments on concept approval and design approval applications (see 'Chapter 4 – Build Approval Process'), and reviews LVVTA's low volume vehicle standards during their development processes.

In recent years the TAC has been responsible for developing the technical content of this Car Construction Manual, and after the release of the manual, will be responsible for the on-going improvements and additions to it.

The TAC also provides the role of assessing whether or not something that is normally precluded by the technical requirements contained in this manual, can in fact, due to unusual or special circumstances, be used safely. It is accepted that no matter how hard we all try, a set of technical requirements such as those in this manual sometimes won't correctly fit a certain situation. By the very nature of the car-building hobby, we all want to do something that's different in some way to that which everyone else is doing.

Innovation and changes in technology therefore, will sometimes catch the TAC out, and determine that while the manual says a certain thing can't be done or a certain component can't be used, in fact within a certain criteria or set of conditions, it can be safely done or used.

Because of this, the TAC will always provide the role of considering an individual application, on a case-by-case basis, from a builder who wants to do something in a way that is outside of, or precluded by, the requirements in this manual. Where appropriate, the TAC will provide individual approval in writing, to enable that builder to do what it is that he or she wants to do, which in turn will need to be passed onto the LVV Certifier by the builder at the time of LVV certification. If you want to have your unusual situation (that is normally precluded by these technical requirements) considered, address your question in writing to the LVVTA Technical Team at the Wellington LVVTA office (see contact details in 2.12 below), and they will make a representation to the TAC on your behalf at the next TAC meeting, and communicate back to you accordingly.

2.11 Suggestions for improving this manual

It has been stated earlier that this manual has been designed in such a way as to be easily amended, and the intention is that improvements and updates by way of amendment will be an integral part of the life of this manual.

The LVVTA welcomes any comments or ideas that readers might have, and encourage them to feed back any information that might enable the manual to be improved for hobby car builders as time goes by.

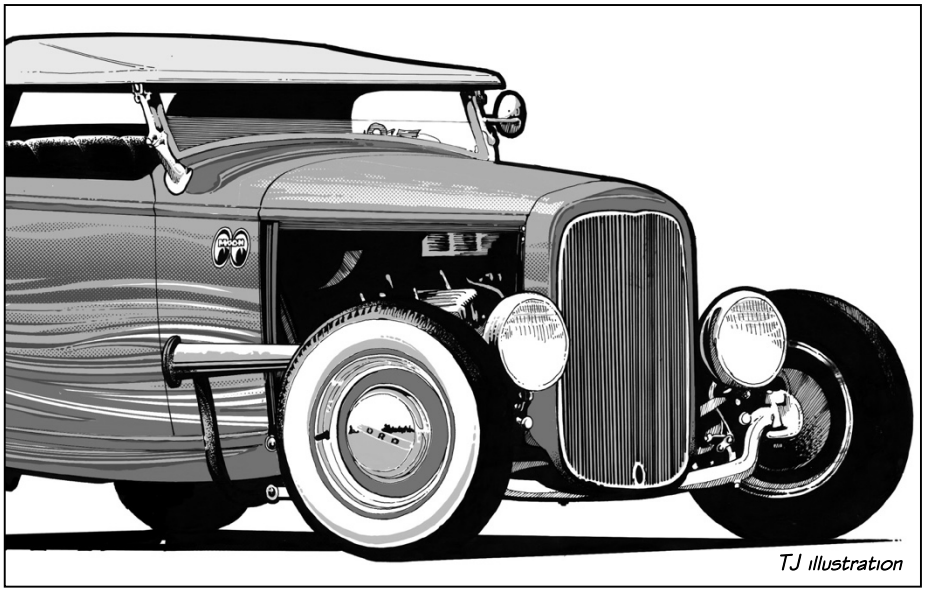
Please feel free to forward any comments or suggestions that you might have, in writing, to LVVTA, either to their postal address, or to their e-mail address, both of which are available from their website www.lvvta.org.nz.

2.12 Who to go to for help

If at any time you feel that the technical decisions, or any other aspect of the LVV certification process, has been unfair or unreasonable, you are able to discuss the situation with LVVTA, who you can contact via tech@lvvta.org.nz, or via the contact details on their website www.lvvta.org.nz.

Chapter 3:

AUTHORITY CARD PROCESS

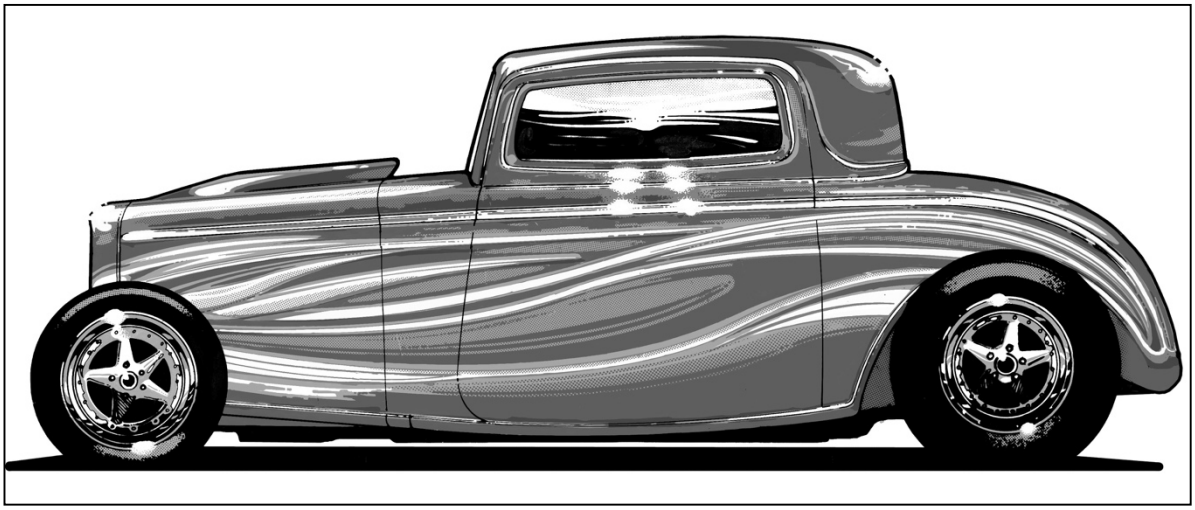


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Key: (for full key details, refer to 'Chapter 2 – About this Manual')

Normal type: Provisions of the NZ Car Construction Manual for all vehicles
Italic type: *Extracts from any relevant LVVTA Low Volume Vehicle Standards*
Script type: Helpful hints, tips, explanations, clarifications, and interpretations
Shaded text & dotted vertical stroke in margin: Latest amendments since previous version



TJ illustration

CHAPTER 3: AUTHORITY CARD PROCESS

Introduction:

Historical review of the system

The NZHRA has administered the LVV Fender Exemption Authority Card system concession vigilantly for its members since 1992, using its club and regional Zone Director network to ensure that this privilege is not abused. The system is sometimes criticised as being too restrictive and overly complex, with its conditions of vehicle year, membership period, and use of log books. In considering this issue, it's important to also consider what the options might have been had NZHRA not taken the matter seriously and implemented a robust system. To follow is a brief historical overview of how the system as we know it came to be, as a result of negotiations that took place with the Government over 20 years ago, and some thoughts on how we should be viewing the system we have today as a result of those negotiations and agreements.

The origins of hot rodding

Firstly, a look at the hobby itself. A hot rod in its most pure form, from hot rodding's inception in the 1930's, was simply defined as a motor vehicle modified in such a way as to increase its performance. Aside from the many mechanical modifications being developed at the time, considerable effort was also put into modifying the overall profile of the bodywork in order to lessen its frontal area. Early hot rodders discovered great benefits in reducing the wind resistance of their cars during their constant quest for higher speed, and removal of all fenders together with the running-boards provided the greatest single available improvement in performance, through both increased aerodynamic efficiency and reduced weight. These weekend race vehicles were also every-day commuters, and this single modification created an obvious and immediate distinction between them and everything else on the road. Subsequently, any fender-less pre-war roadsters, coupes, or sedans were quickly recognised as hot rods by the motoring public of the time.

No other type of enthusiast vehicle the world over can be so distinctively characterised by one single and simple modification. The continued design and construction of fenderless hot rods that emulate or replicate hot rodding's traditional vehicles from the early days of the hobby, is a vital part of hot rodding's heritage and culture.

The old MOT system

Previous to the establishment of the current LVV Authority Card system in the early 1990s, the only fender exemption system – if you could call it that – was a letter of exemption that could be issued by the Ministry of Transport (MOT) or the NZ Police, that allowed a specified vehicle user to operate the motor vehicle referred to in the letter without mudguards, subject to certain conditions.

The exemption was not restricted to users of any group or membership type, but it limited the use of the vehicle to such an extent that it was illegal to operate the vehicle for any purpose other than travelling to and from bonafide hot rod club events, and for repairs to keep the vehicle roadworthy.

At the time that NZHRA began the negotiations to establish what we now know as the low volume vehicle certification system with the Ministry of Transport in 1989, the NZ Police and the MOT were aware of wide-spread abuse of the exemption letters, principally that the vehicles were being used for much more than just to and from legitimate hot rod club event activities. The exemption letter system had become considered to be too difficult for the Police and the MOT to monitor, and enforce compliance with, and the system therefore, was to be abolished, leaving rigid compliance with Regulation 76 of the 1976 Traffic Regulations. This regulation clearly stated that "No person shall operate a motor vehicle, unless … it is fitted with a mudguard over each road wheel". There's a bit in between that talks about "if it reasonable and practical to do so", but from the Government's point of view, it is entirely reasonable and practical for old cars to be fitted with mudguards, because that's how they were originally manufactured.

A proposed alternative system rather than abolishment

At the time – around 1991 - NZHRA was leading the way with negotiating with the MOT toward what would become the LVV certification system (as an alternative to the then-proposed Australian Design Rules and Transport Engineers) and had developed a very good relationship with, and had gained considerable credibility with, the MOT. Aware of the difficulties of the fender exemption system of the day, and the intention to close down the ability for genuine enthusiasts to build and drive traditional hot rods, NZHRA entered into additional negotiations with the MOT to gain consideration of an alternative system, rather than scrap the system in its entirety. NZHRA worked to enable the Government officials concerned to gain an appreciation of the historical significance of traditional hot rods that were typically built by returned servicemen throughout the world during the late 1940s and 1950s, and stressed the importance of not losing this important motoring tradition within New Zealand.

There were, are now, and always will be, hot rod enthusiasts who wish to build and drive traditional 1940s-1960s era hot rods, many of which are fenderless. These cars are a direct link to the hobby's roots, and it is vital that the ability to continue to build and drive such vehicles is maintained, so that future generations will always be able to see and enjoy hot rodding's heritage in just the same way that it is important that New Zealand's 19th century architecture is preserved to show us what our country looked like 150 years ago. For this reason, NZHRA now awards the highly-coveted 'Best Traditional Hot Rod' award at all national events to recognise excellence in the build of this style of car.

While the NZHRA log book system is an annoyance to some, it is necessary to operate log books in order to enable people to continue to build cars to compete for these awards, whilst minimising the risk of abuse of the system. But back to the problem of 1991.

In order to resolve the monitoring and enforcement issues that the Government was experiencing with the mudguard exemption letter problem, NZHRA proposed that the national hierarchal structure of NZHRA could achieve the desired results for all parties, and without any resources being required from the Government.

NZHRA was (and still is) in a unique situation in NZ, in that it has a national executive committee, a network of member clubs throughout the country, and in essence, 'area managers' in the form of the Executive Committee members who form a direct link between the member clubs and the national association. The structure is set up in such a way that an individual must belong to an NZHRA member club in order to belong to NZHRA, and the member clubs' own internal management structures create a unique situation where the actions of each individual member in the country is effectively overseen at a local level by the member club committees, in turn providing a monitoring and reporting function back to NZHRA at a national level.

The proposal was based on a system whereby NZHRA would issue a fender exemption 'authority card' to members (and vehicles) who met specified criteria, provided that its member clubs undertook the role of endorsing the character of its member and supported (in writing) the application, and then took responsibility for each member it supported by monitoring the behaviour of each member. This would ensure that the system, and the hobby, was not bought into disrepute with the accompanying risk of jeopardising the future of the fender exemption authority card system for everyone.

It was proposed that each authority card would be renewed annually, and the member clubs could, and would be expected to, revoke their endorsement of any member who operated outside of the conditions established by NZHRA. A national structure and network would, therefore, vet each application, and monitor the behaviour of each authority card holder on an ongoing basis. It was thought that this structure could give the Government the necessary confidence that an outside organisation could in fact take responsibility for such a job, and do it well.

The new system accepted and incorporated within legislation

The system was proposed, accepted in principle, developed, and agreed in legislation through the Land Transport Compliance Rule. It has proven to work very well, with NZHRA and its member clubs taking the situation seriously and doing an excellent job – an obvious outcome given that the ability to continue to have such a system depends entirely on NZHRA's performance in administering it. In other words, NZHRA and its members have everything to lose if they screw up, therefore the job gets done well.

The legal mechanism that gives the system its legal standing is in paragraph 2.4(7)(e) of the Land Transport Vehicle Equipment Rule 2004 (Rule 32017), which states that the only vehicles that can be legally operated without mudguards (apart from a vehicle on a trade plate, a straddle truck or a forklift etc) is "...a motor vehicle for which a valid low volume vehicle authority card has been issued for the vehicle and its operator in accordance with the Low Volume Vehicle Code."

In turn, Annex 5 (Specific purposes covered by a LVV authority card) of the Low Volume Vehicle Code authorises the NZHRA card system by stating "Compliance with Chapter 3, LVV Authority Card, under the Car Construction Manual (CCM) of the New Zealand Hot Rod Association (Inc), covering only those components and systems that do not comply with applicable requirements for general use on the road and valid for a maximum period of 12 months only". Then in turn again, Chapter 3 of the CCM specifies the eligibility criteria that must be met.

Essentially, the LVV Authority Card system administered by NZHRA to enable fenderless hot rods to be built and driven is a means by which certain people are able to drive certain types of vehicles that feature certain characteristics which would otherwise be prohibited by law.

History has shown that the NZHRA and the Government got it right. The clear national structure, heirachy, conditions, and checking processes that sit behind the authority card system to protect it against abuse have provided a good outcome over two decades, during which time the Government has been able to develop a high degree of confidence in the system.

In summary

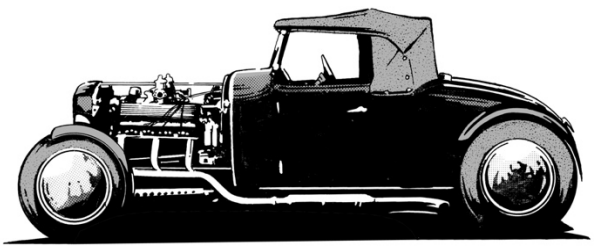
In summary, it's important to understand and remember that this process is the only mechanism by which the Government can be assured that certain vehicles which would ordinarily not be allowed on New Zealand roads, can in fact continue to be built and driven despite having characteristics that would otherwise make them illegal.

This whole issue also has to be considered within the context of the time, and the country we live in. New Zealand, in the 21st century is – like it or not - increasingly focused on safety, environmental, and social issues, including those that relate to motor vehicles. Our regulators are safety-conscious and environment-conscious, sometimes it would seem to the point of being unwilling to allow people to take responsibility for their own actions. There are increasingly greater expectations of vehicle safety for vehicle occupants, other road users, and pedestrians. Whether or not we like or agree with this focus, that's how it is. None of us can change that. We all have to recognise that – and none more-so than those who dislike some details of the NZHRA Fender Exemption system - it's not 1960 anymore.

We have a system that allows us to build and drive traditional hot rods – with few restrictions of use, providing that we drive in a sensible and considerate manner. We need to be happy with the few small inconveniences associated with the system, or accept the only alternative - which is no fender exemption system at all.

Extension of Authority Card system

In 2006, the scope of NZHRA's LVV Authority Card system was expanded to also cover occupant protection systems. Some street registered vehicles are also used to compete in drag racing events such as NZHRA Closed Road Drag Racing events, or New Zealand Drag Racing Association (Inc) (NZDRA) Sportsman Drag Racing events. Under both organisations' rules of eligibility to compete, some vehicles are required to be fitted with a roll-cage and competition style 4, 5, or 6 point full-harness seatbelts, for additional safety over and above the original vehicle manufacturer's safety systems because of the high speeds attained during the competition events. As these alternative forms of driver restraint are not recognised as one of the seatbelt types approved by Land Transport Rules, this NZHRA Occupant Protection LVV Authority Card system allows for their installation and use when installed and used according to the technical requirements of the NZDRA, for a vehicle that is operated by a person who holds a competition licence, and for which a competition logbook is issued. Note that MotorSport New Zealand offers a parallel system for their members, which includes occupant protection, alternative glazing, and hydraulic handbrakes.



Form 3A – Fender Exemption (Initial) Application

Note to the applicant: Please complete PARTS 1 and 2 of this application form, and present it to the New Zealand Hot Rod Association (Inc) (NZHRA)-endorsed Low Volume Vehicle Certifier that you have chosen to carry out your LVV certification at the time of your final inspection. Together with this form, present your Vehicle Identification Number (VIN), your letter of support from your NZHRA-Member Club, and your application and processing fee (see NZHRA's website www.hotrod.org.nz for the current fee). This form will be completed and forwarded to NZHRA by the LVV Certifier.

PART 1 – To be completed by the Applicant:		
Name:		Date of Birth:
Address:		
Phone: (hm)	(wk)	(cell)
NZHRA Club:	(Zone)	(Affiliation #)
Vehicle: (Make)	(Model)	(Year)
VIN (chass # if no VIN):		Reg # (if available):

PART 2 – Declaration by the Applicant:	
In applying for this NZHRA Fender Exemption LVV Authority Card, I agree to abide by the terms and conditions of the approval and issue of an NZHRA Fender Exemption LVV Authority Card, and accept that any breach of these terms and conditions may result in the revocation of my NZHRA Fender Exemption LVV Authority Card, and further, may result in NZHRA's refusal to issue another Authority Card in my name in the future. I declare that the information provided in PART 1 is correct.	
Name:	
Signed:	Date:

Ensure that, accompanying this application form, there is:

- either affixed to the vehicle, or provided by way of documentation, the 17-digit VIN (Vehicle Identification Number) for this vehicle (or chassis number if a VIN is not required to be issued); and
- a letter of support from your NZHRA Member Club; and
- the application and processing fee (see NZHRA's website www.hotrod.org.nz for the current fee), which may be made by cheque or credit card transaction. Please do not send cash.

If paying by credit card, please debit my VISA or MASTERCARD (circle applicable card type):

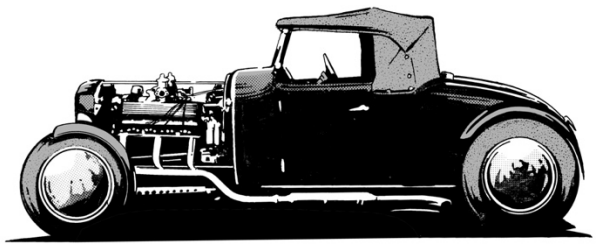
Card #: □□□□ □□□□ □□□□ □□□□ Expiry date:_____

Name on card:_____

Signed:_____ Date:_____

PART 3 – Declaration by the NZHRA-endorsed LVV Certifier:	
I have inspected the vehicle described in PART 1, and confirm that the vehicle meets the acceptance criteria for the issue of an NZHRA Fender Exemption LVV Authority Card, and that the vehicle has been certified to the Low Volume Vehicle Code, and meets all applicable technical safety requirements.	
Name of NZHRA-endorsed LVV Certifier:	
Signed:	Date:
Comments:	
Contact phone # of NZHRA-endorsed LVV Certifier:	

NZHRA Office use only:		
Fee (see www.hotrod.org.nz for the current fee) received by:		Date:
NZHRA receipt #:	Paid by:	
LVV certification plate #:	Date received:	
Application approved by:		Card #:
Signed:		Date:



3.1 Criteria & conditions of Fender Exemption Authority Card

Initial application eligibility:

1. In order to be eligible for an NZHRA Fender Exemption LVV Authority Card:

   (a) the applicant must be the registered owner of the vehicle for which the fender exemption is being issued, which must be confirmed by LVVTA at the time of processing the LVV certification plate application; and

   (b) the applicant must have been an NZHRA-affiliated member of an NZHRA affiliated club for at least 12 months immediately prior to the time of application of NZHRA Fender Exemption LVV Authority Card, which must be confirmed by NZHRA office records; and

   (c) not less than two duly authorised and current club committee members from the applicant's NZHRA Member Club must confirm the good character of the applicant by endorsing the applicant in writing on a club letterhead, providing their names, club positions, signatures, and date of signing, and in doing so take responsibility for his or her behaviour whilst driving the vehicle in question; and

   (d) the vehicle for which the fender exemption is being issued must have a tare weight of not more than 1318 kgs (2900 lbs); and

   (e) the body-style of the vehicle for which the NZHRA Fender Exemption LVV Authority Card is issued must be pre-1935; and

   (f) the vehicle for which the NZHRA Fender Exemption LVV Authority Card is being issued must have been certified to the Low Volume Vehicle Code by an NZHRA-endorsed LVV Certifier (regardless of the vehicle's construction date).

Continuation of exemption eligibility:

2. Fenderless vehicle owners must:

   (a) wherever possible, avoid driving in built-up heavy traffic areas during wet weather; and

   (b) wherever possible, avoid driving through road-works, or on gravel, or any other surface at any speed or manner that may flick up stones, mud, or debris, over any other motorist or pedestrian; and

   (c) not drive in any manner or place that may be a nuisance, or cause annoyance or concern to any other road user or pedestrian; and

   (d) enter not less than two NZHRA-sanctioned events during each year for which a NZHRA Fender Exemption LVV Authority Card is issued, and at each event entered have the log book validated by a duly authorised representative of the host club.

Renewal:

3. Annually, each NZHRA Zone Director receives a list of members with exemptions within their zone.

4. All renewals are due on the 31st August annually, regardless of when they were first issued. The NZHRA office will forward an NZHRA Fender Exemption LVV Authority Card Renewal Form, to all members who have an NZHRA Fender Exemption LVV Authority Card. The member is to fill out the Renewal Form and forward it to their relevant Zone Director, together with the log book and appropriate fee. The Zone Director will, where all criteria are met, sign it off, and forward it to the NZHRA office.

Revocation:

5. Failure to adhere to any of the rules contained in 3.1 (eligibility and rules) will immediately result in a written warning or notice of revocation from NZHRA. In some cases a member may receive a written warning from the applicable Zone Director stating the specifics of concern, and warning that further misconduct will incur immediate loss of exemption. In the case of a warning from a Zone Director, copies of warnings will be sent to NZHRA and the committee of the member's club. Any further breach after a written warning has been issued will result in immediate revocation of the NZHRA Fender Exemption LVV Authority Card by the NZHRA Office.

6. In the case of a revocation being carried out, official notification will be forwarded to the New Zealand Transport Agency and the New Zealand Police. The vehicle owner has the right to appeal the decision through the NZHRA complaints procedure. The NZHRA Executive Committee at their next quarterly meeting will consider any such appeals and provide a final decision.

7. The New Zealand Hot Rod Association (Inc) reserves the right, and will exercise that right, to immediately revoke any NZHRA Fender Exemption LVV Authority Card from any member who is found to have acted in any way or operated a fenderless hot rod in any way that may bring the NZHRA Fender Exemption LVV Authority Card system into disrepute. This will be done in order to protect the future of the NZHRA Fender Exemption system for the ongoing benefit and enjoyment of its members, present and future, who drive their fenderless hot rods responsibly and considerately.

8. NZHRA Fender Exemption LVV Authority Cards are not transferable either to another vehicle or to any other person.

3.2 Application procedure for Fender Exemption Authority Card

To follow is the procedure that is to be applied when an NZHRA member requires an NZHRA Fender Exemption LVV Authority Card. By following this procedure, the process will work smoothly and effectively for everyone involved.

9. Vehicle owner goes to Transport Service Delivery Agent (such as VTNZ, VINZ, or AA) and has a Vehicle Identification Number (VIN) allocated to the vehicle.

10. Vehicle owner obtains a letter of endorsement from his NZHRA member club (refer to 3.1(b) for details).

11. Vehicle owner presents the vehicle to the NZHRA-endorsed LVV Certifier for LVV inspection and certification, also providing to the LVV Certifier Fender Exemption (Initial) Application Form 3A, with PART 1 and PART 2 filled out by the applicant.

12. Upon completion of LVV inspection, the NZHRA-endorsed LVV Certifier signs off Part 3 of the Fender Exemption (Initial) Application Form 3A, and forwards it (together with the letter of endorsement from applicant's Member Club, and applicable fee) to NZHRA for approval and issue. (Note that the VIN must be recorded on the application form, whereas the registration number is not mandatory).

13. NZHRA approves (or declines) the application. If approved, NZHRA forwards to LVVTA a letter of confirmation that the applicant and vehicle has met the criteria and that an authority card will be issued. If declined, that advice is returned to the NZHRA-endorsed LVV Certifier who informs the owner that fenders will be required to be fitted before the LVV certification plate can be affixed.

14. Upon receipt of the Fender Exemption LVV Authority Card letter of confirmation from NZHRA, and the LVV Certification Plate application (with relevant form-sets and supporting documentation) from the NZHRA-endorsed LVV Certifier, LVVTA will manufacture the LVV certification plate, and notify NZHRA of the unique LVV certification plate number.

15. NZHRA will produce the Fender Exemption LVV Authority Card and forward it to the applicant, together with an NZHRA Fender Exemption logbook.

16. LVVTA will engrave the wording "Current NZHRA Fender Authority Card Required" in the Exemptions field of the LVV certification plate, and forward the completed LVV certification plate to the NZHRA-endorsed LVV Certifier.

17. When the LVV certification plate is received, the NZHRA-endorsed LVV Certifier fits it to the vehicle.

18. The owner then presents the vehicle, with LVV certification plate affixed, and the NZHRA Fender Exemption LVV Authority Card, to the TSDA (VTNZ, VINZ, or AA) for entry certification.

Note 1: The processing of applications for NZHRA Fender Exemption LVV Authority Cards is to be handled by Category 1D LVV Certifiers who are endorsed by the NZ Hot Rod Association for the purpose of NZHRA Fender Exemption LVV Authority Card applications, as listed on NZHRA's website, www.hotrod.org.nz.

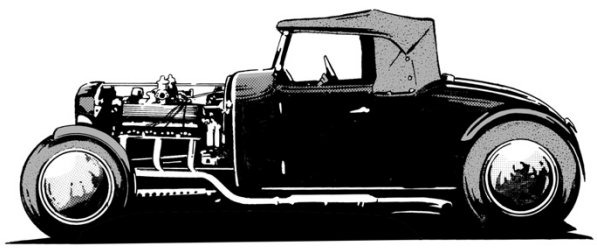
Note 2: Renewals of NZHRA Fender Exemption LVV Authority Cards, after being issued to the vehicle owner by the NZHRA Secretary, are to be given by the vehicle owner (once filled out) to the relevant NZ Hot Rod Association Zone Director for approval, who will then (assuming approval is given) forward the renewal form to NZHRA for processing.

Note 3: If a fenderless vehicle is subsequently fitted with fenders, a replacement LVV certification plate will need to be arranged for the owner, by an NZHRA-endorsed LVV Certifier.

Note 4: If a fenderless vehicle is already LVV certified, and a new owner needs to obtain a fender exemption authority card, the vehicle must be inspected by an NZHRA-endorsed LVV Certifier to ensure that the vehicle matches the details listed on the LVV certification plate, and continues to meet all applicable technical safety requirements.

Note 5: Where a spouse, son, etc also wishes to apply for an NZHRA Fender Exemption LVV Authority Card, they may do so, but must meet all of the requirements specified in 3.1(b) to 3.1(f).

Note 6: Where a vehicle is owned by a trust, business, or similar, proof must be provided that the applicant is a share-holder of the trust, business, or similar.



Form 3A-R – Fender Exemption (Renewal) Application

Note to the applicant: Please complete PARTS 1 and 2 of this application form, and present it to your NZHRA Zone Director. Together with this form and your log-book, attach your application and processing fee (see NZHRA's website www.hotrod.org.nz for the current fee).

This form will be completed and forwarded to NZHRA by your NZHRA Zone Director.

PART 1 – To be completed by the Applicant:		
Name:		Date of Birth:
Address:		
Phone: (hm)	(wk)	(cell)
NZHRA Club:	(Zone)	(Affiliation #)
Vehicle: (Make)	(Model)	(Year)
VIN (chass # if no VIN):		Reg # (if available):
LV Certification Plate #:	Fender Exemption Authority Card #:	

PART 2 – Declaration by the Applicant:	
In applying for the renewal of this NZHRA Fender Exemption LVV Authority Card, I agree to continue abiding by the terms and conditions of the approval and issue of an NZHRA Fender Exemption LVV Authority Card, and accept that any breach of these terms and conditions may result in the revocation of my NZHRA Fender Exemption LVV Authority Card, and further, may result in NZHRA's refusal to issue another Authority Card in my name in the future. I declare that the information provided in PART 1 is correct.	
Name:	
Signed:	Date:

Ensure that, accompanying this application form, there is the application and processing fee of (see NZHRA's website www.hotrod.org.nz for the current fee), which may be made by cheque or credit card transaction. Please do not send cash.

If paying by credit card, please debit my VISA or MASTERCARD (circle applicable card type):

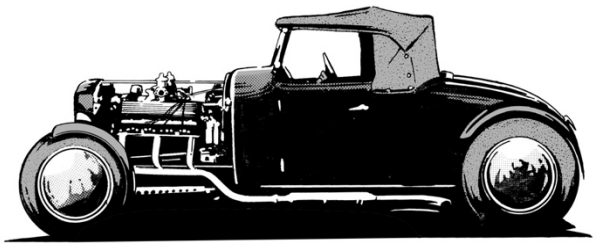
Card #: □□□□ □□□□ □□□□ □□□□ Expiry date:_____

Name on card:_____

Signed:_____Date:_____

PART 3 – Declaration by the NZHRA Zone Director:	
I believe that both the NZHRA member and the vehicle described in PART 1 continue to meet the approval and issue conditions of an NZHRA Fender Exemption LVV Authority Card, and I am not aware of any reason why the applicant's application for renewal should not be granted.	
Name of NZHRA Zone Director:	
Signed:	Date:
Comments:	

NZHRA Office use only:	
Fee (see www.hotrod.org.nz for the current fee) received by:	Date:
NZHRA receipt #:	Paid by:
Renewal application approved by:	Card #:
Signed:	Date:



Form 3B – Occupant Protection (Initial) Application

Notes to the applicant:

- All queries relating to this process must be directed to the New Zealand Drag Racing Association (NZDRA) office 0800 469 372.
- Please complete PARTS 1 and 2 of this application form, and present it to the New Zealand Drag Racing Association (Inc) (NZDRA) Tech Inspector that you have chosen to carry out your Tech Inspection. Together with this form, present your vehicle's competition logbook, and processing fee (see NZHRA's website www.hotrod.org.nz for the current fee). This form will be completed and forwarded to NZHRA by the NZDRA Tech Inspector.

PART 1 – To be completed by the Applicant:		
Name (must be driver of vehicle):		
Address:		
Phone: (hm)	(wk)	(cell)
Vehicle: (Make)	(Model)	(Year)
VIN (chass # if no VIN):		
NZDRA/NZHRA Competition Licence #:	NZDRA/NZHRA Logbook #:	
Competition classification (class):	Best ET/MPH (or KPH):	
Occupant protection systems to which NZHRA Occupant Protection Authority Card applies: ☐ NZDRA-approved competition Roll-cage ☐ NZDRA-approved competition Full-harness Seatbelts		

PART 2 – Declaration by the Applicant:

In applying for this NZHRA Occupant Protection LVV Authority Card, I agree to operate this motor vehicle in a legal and considerate manner whilst on public roads, and I accept that operating this vehicle in any way that could bring the NZHRA's LVV Authority Card system into disrepute may result in the revocation of my NZHRA Occupant Protection LVV Authority Card, and further, may result in NZHRA's refusal to issue another Authority Card in my name again in the future.

I intend to compete in not less than two competition drag racing events annually hosted by either NZHRA or NZDRA, and understand that failure to do this will result in the application for renewal of my NZHRA Occupant Protection LVV Authority Card being declined.

I declare that the information provided in PART 1 is correct.

Name:	
Signed:	Date:

Ensure that, accompanying this application form, there is:

- the vehicle's competition logbook; and
- the application and processing fee (see NZHRA's website www.hotrod.org.nz for the current fee) which may be made by cheque or credit card transaction. Please do not send cash.

If paying by credit card, please debit my VISA or MASTERCARD (circle applicable card type):

Card #: ☐☐☐☐ ☐☐☐☐ ☐☐☐☐ ☐☐☐☐ Expiry date:_____

Name on card:_____

Signed:_____Date:_____

PART 3 – Declaration by the NZDRA Tech Inspector:

I have inspected the vehicle specified in PART 1, and confirm that the vehicle is required by its NZDRA classification and the technical requirements applicable to that classification, to be fitted with roll-protection and full-harness seatbelts.

Further, the vehicle specified in PART 1 meets all applicable technical safety requirements as set out in the applicable NZDRA Safety Regulations section of the NZDRA Rulebook, as summarized in the tables below.

Name of NZDRA Tech Inspector:

Signed: | Date:

Comments:

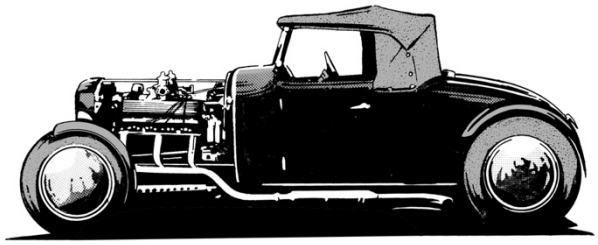
NZDRA-APPROVED COMPETITION ROLL-CAGE

Requirements	Comment	√	X
▪ Correct material specification			
▪ Correct design of roll-cage			
▪ Quality of roll-cage construction			
▪ Correct positioning within vehicle			
▪ Correct attachment to vehicle structure			
▪ Correct padding (type of material, and areas covered)			
▪ Adequate head-space			
▪ Ability to enter and exit			
▪ No impairment of vision			
Comments:			

NZDRA-APPROVED COMPETITION FULL-HARNESS SEATBELTS			
Requirements	**Comment**	**√**	**X**
▪ Recognised manufacturer (specify)			
▪ Meets approved standard (specify)			
▪ Not older than 5 years old or 3 years old (as applicable)			
▪ Condition of webbing			
▪ Correct anchorage design			
▪ Correct positioning of anchorages			
▪ Operation of latching system			
▪ Ability to reach vehicle controls when strapped in			
Comments:			

PART 4 - **New Zealand Drag Racing Association Office use only:**	
Application approved by (NZDRA Executive Officer):	
Signed:	Date:

New Zealand Hot Rod Association Office use only:		
Fee (see www.hotrod.org.nz for the current fee) received by:		Date:
NZHRA receipt #:	Paid by:	
LVV certification plate #:	Date received:	
Application approved by:		Card #:
Signed:		Date:



3.3 Criteria & conditions of Occupant Protection Authority Card

Note that the following technical requirements contained in 3.3(1) and 3.4 are those of the New Zealand Drag Racing Association (NZDRA), and are from the NZDRA Rulebook.

Vehicles required to be fitted with a roll-cage and a full-harness seatbelt:

1. A roll-cage is required by competition regulations to be fitted to the following vehicles:

   (a) for all open cars under 13.00 seconds, and those running slicks, a minimum of a 4-point roll-bar is required;

   (b) for vehicles under 12.0 seconds where monocoque construction has been modified, and all vehicles 11.99 seconds to 11.00 seconds, a minimum of a 4-point roll-bar is required;

   (c) all vehicles under 11.0 seconds as follows:

      (i) 10.99 seconds to 10.00 seconds, a minimum of a 5-point roll-bar; and

      (ii) 9.99 seconds and quicker, a 6-point minimum roll-cage.

2. A minimum of a 4-point 75 mm (3") quick-release safety harness is required in all cars with a roll-bar or roll-cage.

Renewal:

3. Annually, the NZHRA office will forward an NZHRA Occupant Protection LVV Authority Card Renewal Form to all NZHRA and NZDRA competitors who have an NZHRA Occupant Protection LVV Authority Card. All renewals are due on the 31st August annually regardless of when they were first issued.

4. The NZHRA or NZDRA competitor is to fill out the NZHRA Occupant Protection LVV Authority Card Renewal Form and return it to the NZHRA office with the correct fee.

Revocation:

5. The New Zealand Hot Rod Association (Inc) reserves the right, and will exercise that right, to immediately revoke any NZHRA Occupant Protection LVV Authority Card from any NZHRA or NZDRA competitor who is found to have operated a vehicle in any way that may bring the NZHRA Occupant Protection LVV Authority Card system into disrepute. This will be done in order to protect the future of the NZHRA Occupant Protection system for the ongoing benefit and enjoyment of NZHRA and NZDRA competitors, current and future, who operate their dual-purpose race-road vehicles responsibly and considerately.

6. In the case of a revocation being carried out, official notification will be forwarded to the New Zealand Transport Agency and the New Zealand Police. The vehicle owner has the right to appeal the decision through the NZHRA complaints procedure. The NZHRA Executive Committee at their next quarterly meeting will consider any such appeals and provide a final determination.

7. NZHRA Occupant Protection LVV Authority Cards are not transferable either to another vehicle or to any other person.

3.4 Technical requirements for rollbars, roll-cages, and full-harness seatbelts

Note that no vehicles for which an NZHRA Occupant Protection LVV Authority Card is issued, regardless of whether the vehicles are two-door or four-door vehicles, may be fitted with a rear seat. This is because of the risk of roll-bar head-strike for rear seat occupants.

Rollbar design:

8. Dimensions - All rollbars must be within 150 mm (6") of the rear, or side, of the driver's head, extend in height at least 75 mm (3") above the driver's helmet with driver in normal driving position, and at least as wide as the driver's shoulders or within 25 mm (1") of the driver's door.

9. Must be adequately supported or cross braced to prevent forward or lateral collapse of rollbar in case of spin out, collision or upset.

10. Braces must intersect with the rollbar at a point not more than 125 mm (5") from the top of the roll bar. 10.99 to 10.00, a side bar must be included on driver's side and must pass the driver at a point midway between the shoulder and elbow.

11. All rollbar structures must have in their construction a cross-bar for seat bracing and as the shoulder harness attachment point, the cross-bar must be installed no more than 100 mm (4") below, and not above, the driver's shoulders or to side-bar.

Rollbar material and construction:

12. Material - Low carbon (mild) steel tubing is recommended for all types of rollbar construction. Braces must be of same diameter and wall thickness as the rollbar.

13. All chrome-moly welding must be done by approved TIG Heliarc process; mild steel welding is recommended to be MIG or TIG. Welding must be free of slag and porosity. Flush grinding welds prohibited.

14. Due to variations in wall thickness of drawn tubing, competitors are recommended to make allowance in construction (e.g. 3.2 mm [9/64"] wall thickness, in preference to 3.0 mm [1/8"] minimum).

Rollbar attachment:

15. Rollbar must be fully welded or fastened to the frame or frame structure; if car has no frame, a 150 x 150 x 3 mm (6" x 6" x 1/8") steel plate (or a different configuration of the same area) welded to floor, or top and bottom of floor securely bolted together with at least four 10 mm (13/32") bolts and nuts.

Roll-cage design:

16. All cage structures must be designed to protect the driver from any angle, 360 degrees.

17. Dimensions - On all full tube cars, and recommended for all other roll cages, when driver is in driving position, if helmet is forward of main hoop, a helmet bar is required. If no part of the helmet is located forward of the main hoop then a funny car roll-cage with a minimum of four points of attachment must be used.

18. The side-bar must pass the driver at a point midway between the shoulder and elbow, (passenger side bar required). All roll-cage structures must have in their construction a cross-bar for seat bracing and as the shoulder harness attachment point, cross-bar must be installed no more than 100 mm (4") below, and not above, the driver's shoulders or to side-bar.

Roll-cage material and construction:

19. Material - It is recommended that all cage welds be gusseted. All chrome-moly welding must be done by approved TIG Heliarc process; mild steel welding is recommended to be MIG or TIG. Welding must be free of slag and porosity.

20. No tubing will be accepted as chrome-moly that does not bear the 4130 markings. Reynolds 531 tube may be used in place of chrome-moly, with proof of tubing specification required in all cases. Japanese chrome-moly substitute will not be accepted. All tubing in all rollbars and roll-cages except section "A" must be minimum 41 mm x 3 mm (1 5/8" x 1/8") mild steel or 2 mm (.083 thou") chrome-moly. Section "A" may be 32 mm (1 ¼ "). (Refer to the NZDRA rulebook for diagrams that show 'A' sections).

21. Due to variations in wall thickness of drawn mild steel tubing, competitors are recommended to make allowance in construction, (e.g. 3.2 mm [9/64"] wall thickness in preference to 3.0 mm [1/8"] minimum).

Full-harness seatbelts:

22. All seatbelt/harnesses must be securely fastened to the frame, cross-member or reinforced mounting of the vehicle so that the fittings are in direct line with the direction of pull.

23. Any mounting through light panelling such as a stock floor panel is inadequate and will not be permitted without further reinforcement. Where belt fasteners are mounted through such panelling, a plate of no less than 2500 sq mm x 6 mm thickness (2 sq" x ¼") per mounting must be inserted between the outer face of the panelling and belt fastener.

24. All corners and edges of the reinforcing plates must be radiused.

25. Mounting shall be accomplished with a minimum of grade 8.8 metric (grade-5 imperial) bolts at a diameter recommended by the belt manufacturer or 12 mm (7/16") where no recommendation exists. Mounting bolts inserted through belt webbing is prohibited.

26. Shoulder harnesses must be mounted in a manner to prevent them slipping off the shoulders.

27. All points of the seatbelt must be connected in the designed manner at all times when in use and each belt adjusted to give constant firm support to the wearer.

28. Belts must be maintained in good condition and discarded at any sign of belt fraying, nicks or cuts. Any belt deterioration or loss of material colour due to over exposure to sunlight or corrosive chemicals also mandates full replacement.

29. All latching and mounting hardware to be maintained in perfect operating condition.

3.5 Application procedure for Occupant Protection Authority Card

To follow is the procedure to be applied when an NZHRA or NZDRA competitor requires an NZHRA Occupant Protection LVV Authority Card. By following this procedure, the process will work smoothly and effectively for everyone involved.

30. NZHRA or NZDRA competitor fills out PART 1 and PART 2 of the NZHRA Occupant Protection LVV Authority Card Application Form.

31. NZHRA or NZDRA competitor presents the vehicle to the NZDRA Tech Inspector for its tech inspection against the applicable technical and safety requirements of the NZDRA, as specified in section 3.4. Upon completion of NZDRA tech inspection and subsequent approval, the NZDRA Tech Inspector fills out and signs-off the NZDRA Annual Tech Inspection Form, issuing the NZHRA or NZDRA competitor with the pink and white copies of the form.

32. The NZDRA Tech Inspector then carries out the NZHRA Occupant Protection LVV Authority Card Application Form check, and fills out PART 3 of the NZHRA Occupant Protection LVV Authority Card Application Form. The NZDRA Tech Inspector gives the NZHRA Occupant Protection LVV Authority Card Application Form back to the NZHRA or NZDRA competitor.

33. The NZHRA or NZDRA competitor then forwards the white copy of the NZDRA Annual Tech Inspection Form, and the NZHRA Occupant Protection LVV Authority Card Application Form (together with the application fee) to the NZDRA Executive Officer. Do not post – courier only.

    The competitor should retain the pink copy in case he or she ever loses their logbook – the pink copy will enable a new logbook to be issued without a new tech inspection.

34. The Executive Officer of NZDRA confirms that all criteria are met by the competitor, completes PART 4 of the NZHRA Occupant Protection LVV Authority Card Application Form, and forwards the form to NZHRA for approval and production of the NZHRA Occupant Protection LVV Authority Card.

35. NZHRA approves (or declines) the application, produces the NZHRA Occupant Protection LVV Authority Card and returns the Authority Card to the NZDRA. (If declined, that advice is returned to the NZDRA who informs the competitor that the application has been declined).

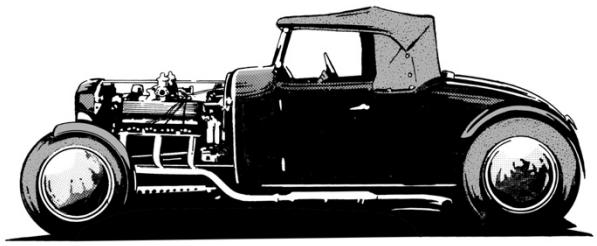
36. The NZDRA forwards the NZHRA Occupant Protection LVV Authority Card to the NZHRA or NZDRA competitor, together with their competition logbook.

37. The vehicle owner is responsible for ensuring that the vehicle for which the Occupant Protection Authority Card is issued, has a valid LVV Certification Plate with "Current NZHRA Authority Card required" engraved in the Exemption field of the Plate. Owners of vehicles with an LVV certification plate already issued can arrange for a new LVV certification plate with wording by contacting an NZHRA-endorsed LVV Certifier.

Note 1: The safety tech inspection for NZHRA Occupant Protection LVV Authority Cards is to be handled by any NZDRA Tech Inspector. These are listed, together with the contact details, on the NZDRA website, www.nzdra.co.nz.

Note 2: If the NZHRA or NZDRA competitor already has a competition logbook, he or she is to return this to their Tech Inspector with their vehicle and pink copy of their Tech Inspection form. The Tech Inspector will validate the vehicle and the competitor's pink copy against his own file yellow copy, then apply the process starting at step 3.

Note 3: Applications for renewals of NZHRA Occupant Protection LVV Authority Cards are to be made in the same way as the initial application, coinciding with the annual tech inspection and competition logbook renewal, using the NZHRA Occupant Protection LVV Authority Card Renewal Application Form.



Form 3B-R – Occupant Protection (Renewal) Application

Note to the applicant:

- All queries relating to this process must be directed to the New Zealand Drag Racing Association (NZDRA) office 0800 469 372.
- Please complete PARTS 1 and 2 of this application form, and present the form to your NZDRA Tech Inspector, coinciding with your annual Tech Inspection. Together with this form, send your pink copy of your NZDRA Annual Tech Inspection Form, your vehicle's competition logbook, and processing fee (see NZHRA's website www.hotrod.org.nz for the current fee). Send this only by courier – do not post.

PART 1 – To be completed by the Applicant:		
Name (must be driver of vehicle):		
Address:		
Phone: (hm)	(wk)	(cell)
Vehicle: (Make)	(Model)	(Year)
VIN (chass # if no VIN):	Reg # (if available):	
NZDRA/NZHRA Competition License #:	NZDRA/NZHRA Logbook #:	
Competition classification (class):	Best ET/MPH (or KPH):	
Occupant protection systems to which NZHRA Occupant Protection Authority Card applies: ☐ NZDRA-approved competition Roll-cage ☐ NZDRA-approved competition Full-harness Seatbelts		

PART 2 – Declaration by the Applicant:	
In applying for the renewal of this NZHRA Occupant Protection LVV Authority Card, I agree to operate this motor vehicle in a legal and considerate manner whilst on public roads, and I accept that operating this vehicle in any way that could bring the NZHRA's LVV Authority Card system into disrepute may result in the revocation of my NZHRA Occupant Protection LVV Authority Card, and further, may result in NZHRA's refusal to issue another Authority Card in my name again in the future. I declare that the information provided in PART 1 is correct.	
Name:	
Signed:	Date:

Ensure that, accompanying this application form, there is:

- the vehicle's competition logbook; and
- the application and processing fee (see NZHRA's website www.hotrod.org.nz for the current fee) which may be made by cheque or credit card transaction. Please do not send cash.

If paying by credit card, please debit my VISA or MASTERCARD (circle applicable card type):

Card #: ☐☐☐☐ ☐☐☐☐ ☐☐☐☐ ☐☐☐☐ Expiry date:_____

Name on card:_____

Signed:_____Date:_____

PART 3 – Declaration by the NZDRA Tech Inspector:

I have inspected the vehicle specified in PART 1, and confirm that the vehicle is required by its NZDRA classification and the technical requirements applicable to that classification, to be fitted with roll-protection and full-harness seatbelts.

Further, the vehicle specified in PART 1 meets all applicable technical safety requirements as set out in the applicable NZDRA Safety Regulations section of the NZDRA Rulebook, as summarized in the tables below.

Name of NZDRA Tech Inspector:

Signed:	Date:

Comments:

NZDRA-APPROVED COMPETITION ROLL-CAGE

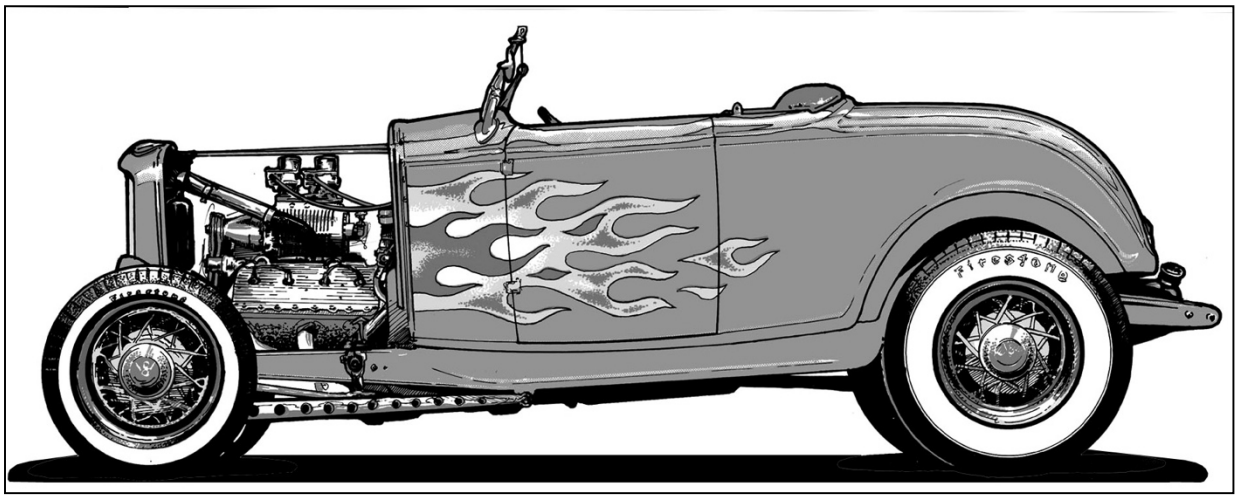
Requirements	Comment	√	X
▪ Correct material specification			
▪ Correct design of roll-cage			
▪ Quality of roll-cage construction			
▪ Correct positioning within vehicle			
▪ Correct attachment to vehicle structure			
▪ Correct padding (type of material, and areas covered)			
▪ Adequate head-space			
▪ Ability to enter and exit			
▪ No impairment of vision			

Comments:

NZDRA-APPROVED COMPETITION FULL-HARNESS SEATBELTS			
Requirements	**Comment**	**√**	**X**
▪ Recognised manufacturer (specify)			
▪ Meets approved standard (specify)			
▪ Not older than 5 years old or 3 years old (as applicable)			
▪ Condition of webbing			
▪ Correct anchorage design			
▪ Correct positioning of anchorages			
▪ Operation of latching system			
▪ Ability to reach vehicle controls when strapped in			
Comments:			

PART 4 - New Zealand Drag Racing Association Office use only:	
Application approved by (NZDRA Executive Officer):	
Signed:	Date:

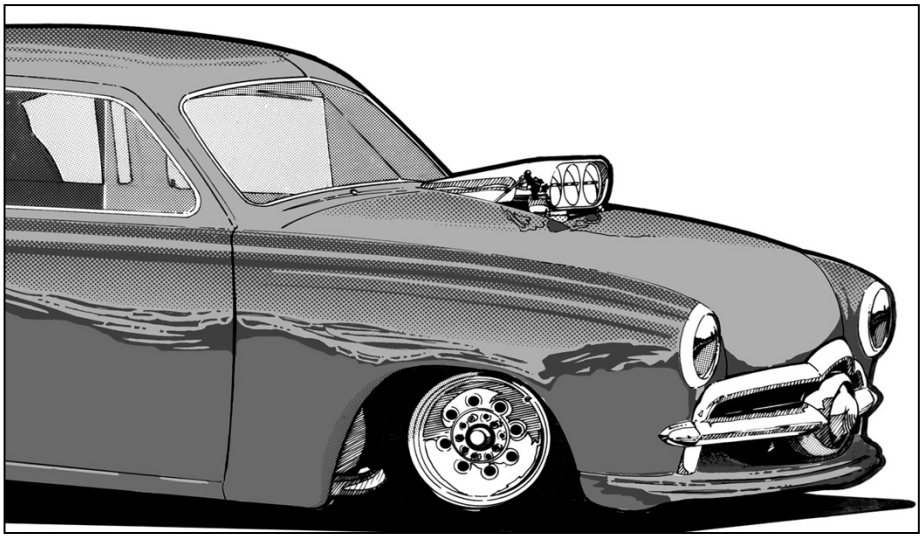
New Zealand Hot Rod Association Office use only:	
Fee (see www.hotrod.org.nz for the current fee) received by:	Date:
NZHRA receipt #:	Paid by:
Application approved by:	Card #:
Signed:	Date:



TJ illustration

Chapter 4:

BUILD APPROVAL PROCESS

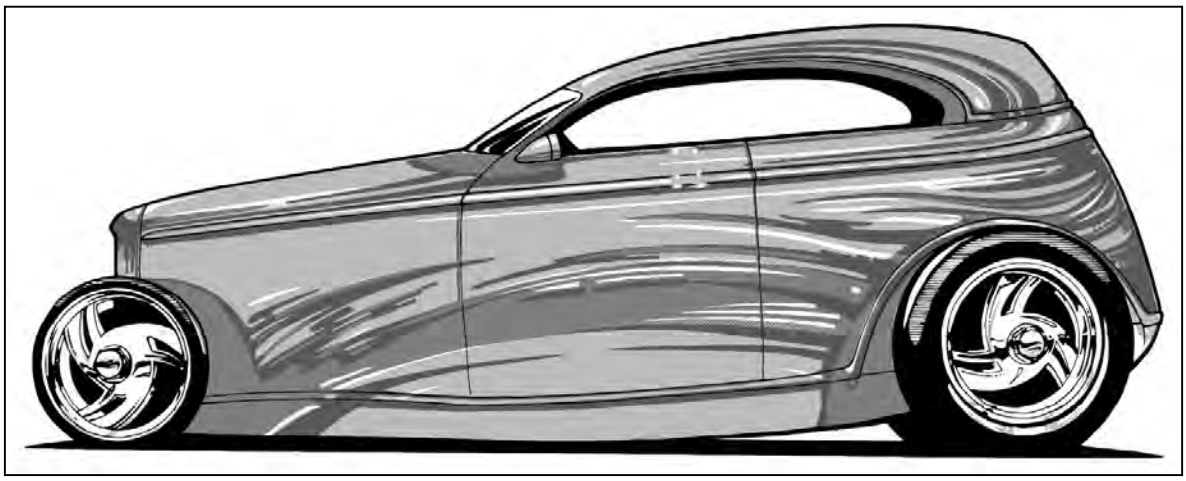


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Key: (for full key details, refer to 'Chapter 2 – About this Manual')

Normal type: Provisions of the NZ Car Construction Manual for all vehicles
Italic type: *Extracts from any relevant LVVTA Low Volume Vehicle Standards*
Script type: Helpful hints, tips, explanations, clarifications, and interpretations
Shaded text & dotted vertical stroke in margin: Latest amendments since previous version



TJ illustration

CHAPTER 4: BUILD APPROVAL PROCESS

Introduction

This Build Approval Process is aimed at builders of all scratch-built or substantially modified vehicles. Please note that the Build Approval Process is a voluntary one, and is not a mandatory part of the LVV process. It's here to help you, if you want help or peace of mind. The system has been developed to enable assistance to be provided to modifiers and constructors, by experienced specialists within the car-building hobby who have a good understanding of vehicle construction, and the complex regime of new regulatory requirements progressively introduced by the New Zealand Government since 1990. Blindly forging ahead and building a low volume vehicle in this regulated age can result in costly and time-consuming consequences. The purpose of this Build Approval Process is to assist vehicle builders and modifiers in achieving their aims and objectives in relation to car construction, and to get them through the low volume vehicle certification process as painlessly as possible.

The system for which this document is provided, has been established to help builders and modifiers, not to hinder them. This chapter may look at first glance like more bureaucracy, but in fact, it is quite the opposite. By providing the Technical Advisory Committee with information on what you want to do, these experts can help you by pointing out any potential areas of concern, ideas which could save you time, or processes which could produce better results. The main objective of this process is to provide you with the best possible chances of building a vehicle that will meet the requirements of the LVV certification process when, inevitably, you reach that critical point. Note that there is no charge for this service; the Technical Advisory Committee members are volunteers. The fee is just to cover the cost of copying, collating, and postage of your application to the committee members.

The essential ingredient in achieving this aim successfully is the information provided by you, the builder. The system can only advise based on the information supplied to it, and that's the purpose of the forms contained within this chapter. The better the information the builder can provide, the more detailed advice and protection the system can provide back to the builder.

In addition to using this Build Approval Process, the best advice available to a vehicle modifier or builder is to make contact with an LVV Certifier at an early stage so that he can guide you down the right path. It's important to use an LVV Certifier who has lots of hands-on practical experience in car building, such as hot rod or sports car construction, so that you can benefit from the combination of that LVV Certifier's practical car building expertise, plus his knowledge of the Low Volume Vehicle Certification system.

Concept Approval application procedure

The Concept Approval Application Form 4A is to be used when your project plan is just a concept, and you want confirmation that the idea you have in mind can be legally built. This is generally intended for projects that are out of the ordinary, or are particularly unique in some way.

Before filling out this Concept Approval Application Form 4A:

1. Establish the basic concept and elements of the vehicle that you propose to build or modify.

1. Establish which LVV Certifier you intend to use to inspect the vehicle for LVV certification during its construction. The offices of the Low Volume Vehicle Technical Association can provide you with contacts for the most appropriate certifiers, or other specific expert advice if necessary.

   A list of LV1D-category LVV Certifiers can be obtained from the LVVTA website, www.lvvta.org.nz.

2. Read through the Concept Approval Application Form 4A thoroughly to gain an understanding of what is required before you begin to fill it out.

While filling out this Concept Approval Application Form 4A:

3. Where components or systems are not known, or have not been selected at the time of submitting your Design Approval Application Form, enter "Not known" or "NK" in the appropriate spaces provided.

4. On modified vehicles, where a component or system is original for the vehicle to which it is fitted, and is not modified in any way, enter "Standard" or "STD" in the appropriate spaces provided.

5. Where information is asked for which does not apply to your project (eg. "Kingpins" and your front suspension is of the type which does not incorporate kingpins), enter "Not applicable" or "NA" in the appropriate spaces provided.

6. Fill out the form neatly and clearly, providing as much information as you are able to, and provide drawings wherever they are required to be provided, and number them accordingly.

7. Provide any drawings required on A4 sized paper only.

8. Use only black or blue pen (no other coloured pens or any type of pencils, as the Form has to be able to be photocopied and distributed to the Technical Advisory Committee (TAC) members of the Low Volume Vehicle Technical Association (Inc) (LVVTA).

9. Write any questions that you would like answered by the TAC members of the LVVTA in the appropriate boxes provided within the respective sections. Where possible, they will give you whatever guidance and assistance they can, based on their knowledge and experience.

After filling out this completed Concept Approval Application Form 4A:

10. Take a photocopy of your completed Concept Approval Application Form for your records, in case of loss during postage.

11. Send the completed Concept Approval Application Form to the Low Volume Vehicle Technical Association (Inc), PO Box 50-600, Porirua 5024, Wellington, together with the fee of $95-00 inc GST. (This address and fee may change from time to time – check the LVVTA website to ensure that the address and fee is correct).

12. Upon receipt, your completed Concept Approval Application Form will be copied and distributed to each member of the LVVTA TAC, and then discussed by the members at a TAC meeting. Further information or clarification may be required from you if the completed Concept Approval Application Form is not filled out sufficiently, if further clarification is required, or if drawings are missing or unclear.

13. Upon the conclusion of discussions relating to your Concept Approval Application Form, the Form will be filled out by the TAC, which may include answers to your questions, specific requirements that your Approval will be subject to, and general comments for you and the LVV Certifier. If approved, a Concept Approval Number will be allocated and noted on the first page of your Concept Approval Application Form.

14. The completed and signed off Concept Approval Application Form will be posted back to you, and a copy will remain on the TAC's files for their future reference.

After you have received your Concept Application Form 4A:

15. If you receive approval in principle for your concept from the LVVTA TAC, you can then proceed with planning your project, confident in the knowledge that, subject to the details being acceptable to the LVVTA TAC and/or the LVV Certifier, your vehicle can be legally put on the road through the LVV certification process.

16. When you have established the details of the vehicle's design and construction, including the components to be used and their sources, attachment systems, and how the project will be tackled, you should fill out Design Approval Application Form 4B.

The Concept Approval Application Form 4A cannot be considered approved by the LVVTA TAC until endorsed by colour-stamping with the approval stamp of the LVVTA TAC on the front page, and at the end of the Form.

Note that this Concept Approval Application Form 4A should not be used if the vehicle is already partially constructed. If construction has already commenced, go straight to the Design Approval Application Form 4A.

Note also that if a Design Approval Application Form 4B is being submitted to the TAC, there is no need to submit a Concept Approval Application Form 4A also. The Concept Approval Application Form 4A is only relevant if you wish to build a vehicle that is out of the ordinary, or is particularly unique in some way, and you haven't started the vehicle's construction.

The fees for a Concept Approval Application or a Design Approval Application are correct at the time of the 1st Amendment of this NZ Car Construction Manual, however this may change from time to time. Ensure that the fee you send in is correct by checking on the LVVTA website www.lvvta.org.nz at the time of your application.

Form 4A – Concept Approval Application

Applicant to fill in:		
Owner's name:		
Address:		
Phone: (hm)	(wk)	(cell)
E-mail address:		
Car Club:		

Applicant to fill in:		
Vehicle: (Make)	(Model)	
Body-style:	Year:	Expected weight:
Is vehicle currently registered?	If registered, date of first reg:	
Has vehicle been previously registered in NZ?		

Technical Advisory Committee use only:	
Fee $95-00 (Inc GST) Received by:	Date:
Certification type:	Category:
Approved CAA form number: (Future reference number)	
Issued by:	Date:

4.1 Project basic outline

Provide details of what stage the vehicle is presently at:

(eg: not started, bare space-frame, etc)

Body and chassis drawings:

Provide on accompanying page(s), in A4 size only, plan view (birds-eye) and side view drawings which will illustrate the basics of the project including any major modifications detailed in the body and chassis sections above.

Describe body type and style including any modifications:

(eg: coupe, roadster, roof-chop, conversion to ute, two-door conversion, open sports, etc)

Describe chassis or frame including any modifications:

(eg: original, RHS-type, space-frame, monocoque, hand-built, material specifications, etc)

Drive-train and mechanical details:

Provide all relevant details relating to the following subjects in the appropriate spaces below:

- Engine make, type, size, and configuration:
- Gearbox make and type:
- Diff:
- Front suspension system:
- Steering system:
- Rear suspension system:
- Front brakes:
- Rear brakes:

- Any other general information in regard to the vehicle's chassis and related components not covered above that you are able to detail at this stage:

Queries from Applicant:

Please note any queries or questions relating to basic design and construction, component selection, or materials of the project that you would like the TAC to respond to:

Technical Advisory Committee use only
Comments from TAC to Applicant:

Technical Advisory Committee use only
Comments from TAC to Certifier at preliminary or chassis inspection:

Technical Advisory Committee use only	
Signed for on behalf of the Technical Advisory Committee:	
Name:	Position:
Signature:	Date:

Design Approval application procedure

The Design Approval Application Form 4B is to be used when your project plan is more than just a concept, and you have a fairly firm and detailed plan in mind of what the various components and systems the vehicle is going to consist of.

Before filling out this Design Approval Application Form 4B:

2. Establish as clearly as you can the design and construction aspects of the vehicle that you propose to build or modify.

3. The LVVTA TAC is well aware that many of the finer details associated with vehicle construction cannot always be fully established at the design stage. However, as much advance planning as is realistically possible should be carried out.

4. Establish which LVV Certifier you intend to use to inspect the vehicle for LVV certification during its construction. The offices of the Low Volume Vehicle Technical Association can provide you with contacts for the most appropriate certifiers, or other specific expert advice if necessary.

   A list of LV1D-category LVV Certifiers can be obtained from the LVVTA website, www.lvvta.org.nz.

5. Read through the Design Approval Application Form 4B thoroughly to gain an understanding of what is required before you begin to fill it out.

While filling out this Design Approval Application Form 4B:

6. Where components or systems are not known, or have not been selected at the time of submitting your Design Approval Application Form, enter "Not known" or "NK" in the appropriate spaces provided.

7. On modified vehicles, where a component or system is original for the vehicle to which it is fitted, and is not modified in any way, enter "Standard" or "STD" in the appropriate spaces provided.

8. Where information is asked for which does not apply to your project (eg. "Kingpins" and your front suspension is of the type which does not incorporate kingpins), enter "Not applicable" or "NA" in the appropriate spaces provided.

9. Fill out the form neatly and clearly, providing as much information as you are able to, and provide drawings wherever they are required to be provided, and number them accordingly.

10. Provide any drawings required on A4 sized paper only.

11. Use only black or blue pen (no other coloured pens or any type of pencils, as the Form has to be able to be photocopied and distributed to LVVTA TAC members).

12. Write any questions that you would like answered by the LVVTA TAC in the appropriate boxes provided within the respective sections. Where possible, they will give you whatever guidance and assistance they can, based on their knowledge and experience.

After filling out this completed Design Approval Application Form 4B:

13. Take a photocopy of your completed Design Approval Application Form for your records, in case of loss during postage.

14. Send the completed Design Approval Application Form to the Low Volume Vehicle Technical Association (Inc), PO Box 50-600, Porirua 5024, Wellington, together with the fee of $150-00 inc GST. (This address and fee may change from time to time – check the LVVTA website to ensure that the address and fee is correct).

15. Upon receipt, your completed Design Approval Application Form will be copied and distributed to each member of the LVVTA TAC, and then discussed by the members at a TAC meeting. Further information or clarification may be required from you if the completed Design Approval Application Form is not filled out sufficiently, if further clarification is required, or if drawings are missing or unclear.

16. Upon the conclusion of discussions relating to your Design Approval Application, the Form will be filled out by the TAC, which may include answers to your questions, specific requirements that your Approval will be subject to, and general comments for you and the LVV Certifier. If approved, a Design Approval Number will be allocated and recorded on your Design Approval Application Form.

17. The completed and signed off Design Approval Application Form will be posted back to you, and a copy will remain on the TAC's files for their future reference.

After you have received your Design Approval Application Form 4B:

18. The completed and signed off Design Approval Application Form should be safely stored, and then provided to your LVV Certifier at each LVV certification inspection that takes place. The Design Approval Application Form must be left in the care of the LVV Certifier if requested, during the LVV certification inspection process.

19. If at any time after your Design Approval Application Form is issued, the design of your vehicle significantly changes during construction from the specifications contained within your Design Approval Application Form, your LVV Certifier should be consulted. He may require you to seek further approval from the TAC.

20. A chassis inspection should be arranged with the LVV Certifier as soon as the vehicle reaches a stage where all engineering aspects of the chassis, suspension, steering, brakes, and drive-train are completed.

21. The number of inspections required during the LVV certification process will vary from vehicle to vehicle. It can depend on the level of confidence the builder has, and the level of confidence the LVV Certifier has in the builder. Generally, a LVV Certifier will require that a scratch-built vehicle undergoes three inspections; a chassis inspection early on (as detailed in item 19), another inspection when the vehicle is nearing completion, and a final inspection when the vehicle is finished and driving.

22. Most of the LVV Certifiers are car-builders themselves, and although they obviously have to make a living from LVV certification, their passion and enthusiasm to help the enthusiast sector will usually result in assistance being provided by them that is above and beyond the call of duty, if you follow their advice and work with them.

Design Approval Application Form 4B cannot be considered approved, until endorsed by colour stamping with the approval stamp of the TAC on the front page, and at the end of each section.

Form 4B – Design Approval Application

Applicant to fill in:		
Owner's name:		
Postal address:		
Phone: (hm)	(wk)	(cell)
E-mail address:		
Car Club:		
Concept Approval Application Number issued: (if applicable)		

Applicant to fill in:		
Vehicle: (Make)	(Model)	
Body-style:	Year:	Expected weight:
Engine: (Make)	(Type)	(Size)
Gearbox: (Make)	(Type)	(No speeds)
Is vehicle currently NZ registered?	If registered, date of first reg:	
Has vehicle been previously registered in NZ?		

Technical Advisory Committee use only:	
Fee $150-00 (Inc GST) Received by:	Date:
Certification type:	Category:
Design Approval Application Number issued: (Future reference number)	
Issued by:	Date:

4.2 Chassis

Describe type of chassis:

(eg RHS, tubular space-frame, monocoque etc)

Describe basic construction method:

Provide details of welder:

(Include name, experience, qualifications if applicable)

Chassis plans:

Provide on accompanying page(s), in A4 size only, plan view (birds-eye) and side view drawings. All items contained within the chassis detail section below should be depicted on the drawings.

Chassis details:

All relevant details relating to material specifications, construction methods, and attachment methods should be provided in the appropriate spaces below:

Main chassis or sub-frame rails:

All cross-members and beams:

Frontal Impact protection provision:

Engine attachment points:

Transmission attachment points:

Brake pedal and master cylinder attachment points:

Suspension attachment points:

- Front:
- Rear:

Body attachment points:

Seat anchorage points:

Seatbelt anchorage points:

Any other general information in regard to the chassis and related components not covered above:

Queries from Applicant (re chassis construction):

Please note any queries or questions relating to the subject of chassis construction that you would like the TAC to respond to:

Technical Advisory Committee use only

Comments from TAC to Applicant (re chassis construction):

In relation to the above queries:

In general:

Technical Advisory Committee use only
Comments from TAC to Certifier (re chassis construction):

4.3 Suspension (Front):

Describe suspension configuration:

(eg beam, tube, strut, IFS etc)

Describe any modifications to the front suspension system:

Describe method of attachment of the front suspension to the chassis/sub-frame:

Provide details of person carrying out modifications and/or attachment:

(Include name, qualifications, ticket #, experience)

Front suspension plans:

Provide on accompanying page(s), in A4 size only, relevant drawings relating to the suspension system being used or proposed for vehicle, in particular where adaptations and/or modifications have taken place, or where aftermarket components are used.

Custom independent a-arm front suspension plans:

In the case of custom or hand-built independent front suspension systems, all details and specifications required within LVVTA Information Sheet "Info 01-2016 - Custom Independent Front & Rear Suspension (IFS/IRS) Approval Application Guide" must be provided separately, including full working drawings. This information sheet is available for download from the LVVTA website, www.lvvta.org.nz.

Front suspension details:

All relevant details relating to component type and attachment methods are to be provided in the appropriate spaces below:

Radius rods: (if applicable)

Type: Modifications:

Suspension bushes/rod ends:

Type:

Springs: (or airbags)

Type:

Coil over shock absorber: (if applicable)

Type: Shock absorber angle:

Lateral control: (panhard bar etc)

Type:

Attachment:

Castor and camber:

Adjustment provision:

Ball joints: Upper:

Vehicle make/model/part number: Lower:

Bump-stops:

Type: Modifications:

Stub axles/uprights:

Vehicle make/model/aftermarket manufacturer type:

Any other general information in regard to the front suspension system not covered above:

Queries from Applicant (re front suspension):

Please note any queries or questions relating to the subject of front suspension that you would like the TAC to respond to:

Technical Advisory Committee use only

Comments from TAC to Applicant (re front suspension):

In relation to the above queries:

In general:

Technical Advisory Committee use only

Comments from TAC to Certifier (re front suspension):

4.4 Suspension (Rear)

Describe suspension configuration:

(eg live axle or independent, leaf, coils, airbags, radius rods, 4-bars, etc)

Describe any modifications to the rear suspension system:

Describe method of attachment of the rear suspension to the chassis/sub-frame:

Provide details of person carrying out modifications and/or attachment:

(Include name, qualifications, ticket #, experience)

Rear suspension plans:

Provide on accompanying page(s), in A4 size only, relevant drawings relating to the suspension system being used or proposed for vehicle, in particular where adaptations and/or modifications have taken place, or where aftermarket components are used.

Rear suspension details:

All relevant details relating to component type and attachment methods are to be provided in the appropriate spaces below:

Radius rods: (if applicable)

Type: Modifications:

Suspension bushes/rod ends:

Type:

Springs: (or airbags)

Type:

Coil over shock absorber: (if applicable)

Type: Shock absorber angle:

Lateral control: (panhard bar etc)

Type: Attachment:

Shock absorber to diff attachment:

Fasteners: Bracketry:

Independent rear suspensions: (if applicable)

Details:

Modifications:

Stub axles/uprights:

Vehicle make/aftermarket manufacturer type:

Any other general information in regard to the rear suspension system not covered above:

Queries from Applicant (re rear suspension):

Please note any queries or questions relating to the subject of rear suspension that you would like the TAC to respond to:

Technical Advisory Committee use only

Comments from TAC to Applicant (re rear suspension):

In relation to the above queries:

In general:

Technical Advisory Committee use only
Comments from TAC to Certifier (re rear suspension):

4.5 Steering

Describe steering configuration and system:

Describe (basically) any modifications to the steering system:

Provide details of person carrying out modifications:

(include name, qualifications, ticket #, experience, and proposed NDT method of any welding)

Steering plans:

Provide on accompanying page(s), in A4 size only, relevant drawings relating to the steering system being used or proposed for vehicle, in particular where adaptations and/or modifications have taken place, or where aftermarket components have been used.

Steering details:

All relevant details relating to component type and attachment methods are to be provided in the appropriate spaces below:

Steering wheel:

Vehicle type or aftermarket manufacturer brand:

Diameter: Hub type (note if collapsible hub):

Upper column:

Donor vehicle make/manufacturer:

Modifications:

Attachment point details of upper column to bulkhead area:

Intermediate shaft:

Donor vehicle make/manufacturer:

Modifications:

Universals:

Donor vehicle make/manufacturer:

Modifications:

Flexible couplings:

Incorporated? Yes/No: If so, donor vehicle make:

Method of collapsibility of steering column system:

Steering box or rack and pinion:

State which: Donor vehicle make/manufacturer:

Modifications:

Steering box drop arm:

Donor vehicle make/manufacturer:

Modifications:

Drag link or tie rod:

Donor vehicle make/manufacturer:

Tie rod ends:

Donor vehicle make:

Modifications:

Steering arms:

Donor vehicle make/manufacturer:

Modifications:

Ball joints:

Donor vehicle make/manufacturer:

Kingpins:

Donor vehicle make/manufacturer:

Any other general information in regard to the vehicle's steering system not covered above:

Queries from Applicant (re steering):

Please note any queries or questions relating to the subject of steering that you would like the TAC to respond to:

Technical Advisory Committee use only

Comments from TAC to Applicant (re steering):

In relation to the above queries:

In general:

Technical Advisory Committee use only
Comments from TAC to Certifier (re steering):

4.6 Brakes

Describe braking system:

(eg disc front, drum rear, dual circuit master-cylinder, non-boosted, etc)

Describe mounting and placement of master cylinder and booster:

Describe mounting and placement of pedal assembly:

Provide details of person carrying out any welding or machining in relation to brake system:

(Include name, qualifications, ticket #, experience, and proposed NDT method if welding)

Brake system details:

All relevant details relating to component type and attachment methods are to be provided in the appropriate spaces below:

Front brakes:

Disc/drum: Solid/vented: Size:

Donor vehicle or aftermarket manufacturer brand:

Rear brakes:

Disc/drum: Solid/vented: Size:

Donor vehicle or aftermarket manufacturer brand:

Wheel cylinders:

Size front: Size rear:

Master cylinder:

Number of circuits: Bore size F: Bore size R:

Donor vehicle or aftermarket manufacturer brand:

Booster:

Boosted on front/back: Location:

Donor vehicle or aftermarket manufacturer brand:

Proportioning valve:

Type: Make: Location:

Roll-control or line-lock bias valves:

Make: Attachment:

Flexible brake hoses:

Type: Make: Standards marking:

Brake pipes:

Tubing material: Attachment:

Brake pedal:

Donor vehicle make/aftermarket manufacturer/custom-built:

Material: Size: Attachment:

Other details:

Brake pedal pushrod:

Donor vehicle make/custom-built:

Length: Diameter: Material:

Other details:

Pedal box: (if applicable)

Donor vehicle make/aftermarket manufacturer/custom-built:

Handbrake system:

Donor vehicle make: Location:

Any other general information in regard to the vehicle's braking system not covered above:

Brake system plans:

Provide on accompanying page(s), in A4 size only, relevant drawings relating to the braking system being used or proposed for vehicle, in particular where adaptations and/or modifications have taken place, or where aftermarket components have been used.

Specific drawing requirements for this section:

- Brake pedal if modified or fabricated
- Brake pedal pushrod if modified or fabricated
- Pedal box if modified or fabricated
- Master cylinder attachment
- Booster attachment

Queries from Applicant (re brakes):

Please note any queries or questions relating to the subject of brakes that you would like the TAC to respond to:

Technical Advisory Committee use only

Comments from TAC to Applicant (re brakes):

In relation to the above queries:

In general:

Technical Advisory Committee use only

Comments from TAC to Certifier (re brakes):

4.7 Wheels & Tyres

Describe any modifications to the wheels:

Provide details of person carrying out modifications:

(Include name, qualifications, ticket #, experience)

Wheel & Tyre details:

All relevant details relating to wheels & tyres to be provided in the appropriate spaces below:

Front wheels:

Brand: Material:

Diameter: Width: Offset (rim center to bolt face):

Rear wheels:

Brand: Material:

Diameter: Width: Offset (rim center to bolt face):

Front tyres:

Brand: Construction type (radial/cross-ply):

Diameter: Width: Speed rating:

Front axle track (centre to centre of tyre treads):

Rear tyres:

Brand: Construction type (radial/cross-ply):

Diameter: Width: Speed rating:

Rear axle track (centre to centre of tyre treads):

Any other general information in regard to the vehicle's wheels and tyres not covered above:

Queries from Applicant (re wheels & tyres):

Please note any queries or questions relating to the subject of wheels & tyres that you would like the TAC to respond to:

Technical Advisory Committee use only

Comments from TAC to Applicant (re wheels & tyres):

In relation to the above queries:

In general:

Technical Advisory Committee use only

Comments from TAC to Certifier (re wheels & tyres):

4.8 Miscellaneous equipment

Equipment details:

All relevant details relating to component type and attachment methods are to be provided in the appropriate spaces below, with drawings provided where requested if applicable.

Differential type:

Donor vehicle make/manufacturer:

Modifications:

Drive-shaft:

Donor vehicle make/manufacturer:

Modifications:

Material specification (if scratch-built):

Drive-shaft builder/modifier (Include ticket details, etc):

Drive-shaft loop:

Design: Material:

Body to chassis attachment:

Attachment details:

Floor-pan and fire-wall:

Modification details:

Body:

Modification details:

Body framing:

Modification details:

Roll bar & roll cage: (provide drawings)

Design: Material:

Rollbar/cage builder: (Include ticket details, etc)

Fuel Tank: (provide drawings if scratch-built)

Donor vehicle make: Modification details:

Material specifications: (if scratch-built)

Fuel tank builder: (Include ticket details, etc)

Attachment position:

Attachment method:

Venting details:

Spillage & drainage details:

Fuel lines:

Hose type: Standards markings:

Any other general information in regard to vehicle's miscellaneous equipment not covered above:

Queries from Applicant (re miscellaneous equipment):

Please note any queries or questions relating to the subject of miscellaneous equipment that you would like the TAC to respond to:

Technical Advisory Committee use only

Comments from TAC to Applicant (re miscellaneous equipment):

In relation to the above queries:

In general:

Technical Advisory Committee use only

Comments from TAC to Certifier (re miscellaneous equipment):

4.9 Regulatory equipment

Regulatory item details:

All relevant details relating to types of components, systems, and attachment methods are to be provided in the appropriate spaces below, with drawings provided where requested:

Headlamps:

Type: Make:

Standards marking: Source:

Park-lamps:

Type: Make:

Standards marking: Source:

Tail-lamps:

Type: Make:

Standards marking: Source:

Indicators:

Type: Make:

Standards marking: Source:

Reflectors:

Type: Make:

Standards marking: Source:

Stop-lamps:

Type: Make:

Standards marking: Source:

High-mounted stop-lamps:

Type: Make:

Standards marking: Source:

Other lights: (Fog, auxiliary, reverse, etc)

Details:

Windscreen:

Type: Material:

Standards marking: Source:

Side & rear windows:

Type: Material:

Standards marking: Source:

Rear view mirrors:

Donor vehicle make or manufacturer brand:

Attachment:

Speedometer:

Donor vehicle make or manufacturer brand:

Sunvisors:

Donor vehicle make: Material spec & attachment details if custom-built:

Seats:

Donor vehicle make or manufacturer brand:

Attachment details:

Seatbelts:

Donor vehicle make or manufacturer brand:

Type: Standards markings:

Windscreen wiper & wash: (provide drawing of swept area)

Donor vehicle make of components or systems used:

Number of wiper arms: Number of speeds:

Washer system:

Interior impact:

Provide general description of layout and components used within the dashboard area, and all interior controls and surfaces forward of the front seats:

External projections:

Provide details of any non-original items or equipment attached to the forward part of the vehicle which could be considered a pedestrian risk:

Door retention system:

Donor vehicle make or manufacturer brand of latch and pin assemblies:

Donor vehicle make or manufacturer brand of hinge assemblies:

Details of door reinforcement between latches and hinges:

Details of striker pin to body reinforcement:

Details of hinge to body reinforcement:

Any other general information in regard to vehicle's regulatory equipment not covered above:

Queries from Applicant (re regulatory equipment):

Please note any queries or questions relating to the subject of regulatory equipment that you would like the TAC to respond to:

Technical Advisory Committee use only

Comments from TAC to Applicant (re regulatory equipment):

In relation to the above queries:

In general:

Technical Advisory Committee use only
Comments from TAC to Certifier (re regulatory equipment):

Technical Advisory Committee use only
Comments from TAC to Applicant regarding project in general:

Technical Advisory Committee use only
Comments from TAC to Certifier regarding project in general:

Technical Advisory Committee use only	
Signed for on behalf of the Technical Advisory Committee:	
Name:	Position:
Signature:	Date:

Useful Information:

Please note that this Build Approval Process and all associated services are designed and applied by motor vehicle hobbyists for the benefit of fellow motor vehicle hobbyists, and are operated on a non-profit basis. The objective of making this service available is to try to minimise the likelihood of a car builder running into major problems at LVV certification time.

By using this process, there is a good chance that any major problems with any aspects of the builder's proposal will be identified by the Technical Advisory Committee, and this can be brought to the attention of the builder before he gets too far down the track with the project.

All efforts have been made, and will continue to be made, to minimise the likelihood of vehicles that have had the Concept and Design Approval processes applied, encountering major problems at LVV certification time. It is, however, the responsibility of the vehicle owner, despite all assistance and advice offered through this service, to ensure that the vehicle complies with all legal requirements relating to low volume vehicle certification.

This can best be assured by closely following the rest of this Car Construction Manual, and also by maintaining close contact with an experienced Low Volume Vehicle Certifier.

Responsibility and Liability:

Vehicle owner/modifier or manufacturer (person responsible for modifications to [or construction of] vehicle) to complete:

I, (full name) ..... in respect of the vehicle(s) or component(s) or system(s) to which this Design Approval Application applies, acknowledge and understand, and submit this application on the basis that there are limitations associated with the Design Approval process. I acknowledge and understand that:

1. The Low Volume Vehicle Technical Association (LVVTA) is a not-for-profit incorporated society, established to provide a technically---sound and economically---viable environment within which New Zealand's motoring public can safely modify, construct, and enjoy unique and specialised motor vehicles for the purposes of recreation, sport, mobility, passenger service, business, and environmental sustainability.
2. The low volume vehicle (LVV) system is an alternative certification process which enables compliance with New Zealand's legislative requirements whilst avoiding otherwise cost-prohibitive methods of demonstrating compliance such as laboratory analysis and crash-testing. LVVTA's Design Approval process is intended as an additional means by which to reduce the likelihood of a modifier or constructor experiencing problems during the low volume vehicle certification assessment process.
3. LVVTA's time and advice is provided free of charge, and on that basis the LVVTA Design Approval process is based on best endeavours as far as can be practically achieved whilst all personnel involved are operating on a voluntary basis. Any fees paid by a Design Approval applicant are to cover the costs of photocopying and distribution of the application documentation to the members of the Technical Advisory Committee (TAC), and other direct cost-recovery for meeting venue hire, refreshments, and mileage reimbursement for members of the TAC.
4. In addition, there are a number of factors that are outside the control of the LVVTA and the low volume vehicle certification system, and which therefore limit the scope of the Design Approval process, which means that any advice or comments provided can only be a guidance-based process, rather than a full engineering analysis and reporting process. These factors include that LVVTA cannot:

    - control the detail or extent of the documentation that is provided or omitted by the applicant as part of the application;
    - in many cases, inspect the vehicle, or the components or systems being assessed;
    - in the case of multi---vehicles, multi---components or multi---systems, control or check on-going quality control or conformity of production of the vehicles or components or systems;
    - influence or control the way in which the vehicle is operated throughout its life;
    - establish the durability-performance of the vehicle, or the components or systems.

5. Because of LVVTA's not-for-profit status, the limited scope of assessment, and the many factors associated with the vehicle or components or systems that are outside of LVVTA's control, LVVTA's approval processes are based on all reasonable best efforts to identify potential safety risks and to provide sound technical advice where appropriate, and LVVTA will not accept any responsibility or liability for any condition, wear, breakage, or failure associated with any modifications or constructional features of any vehicle, component, or system, whether considered or not during the Design Approval Application process, or any consequences of such condition, wear, breakage, or failure including any damage or injury or loss of life.

Signature of person named above ..... Date: .....



TJ illustration

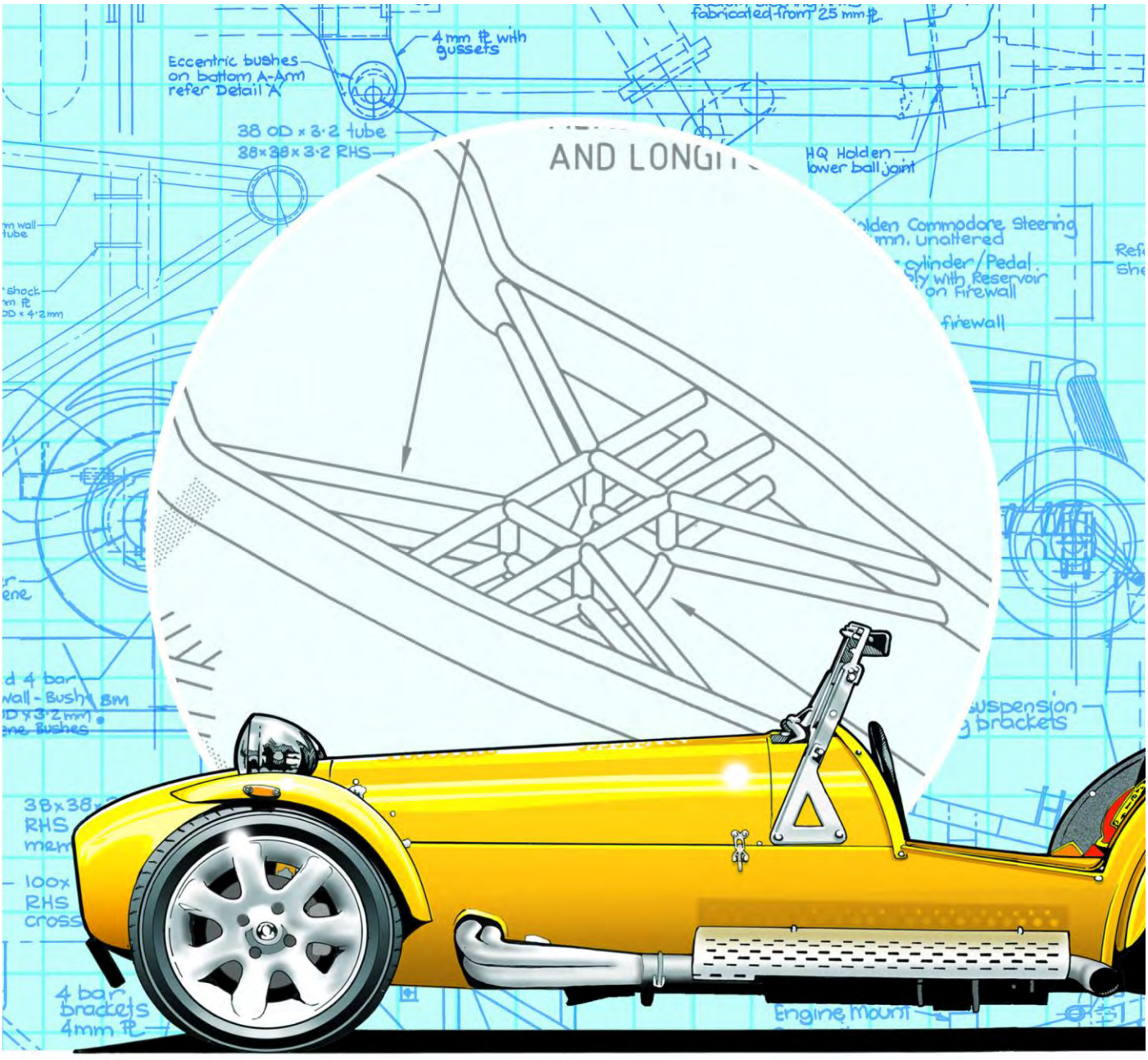
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New Zealand Car Construction Manual

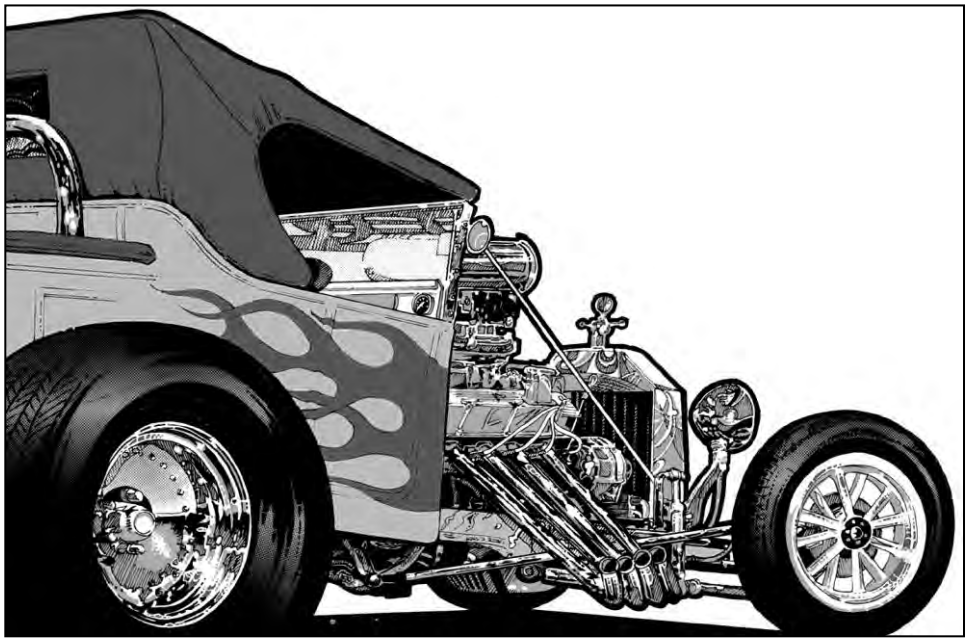
Chapter 5
Chassis Modification & Construction

2nd Amendment | Effective from 1 July 2021



Low Volume Vehicle Technical Association (inc)

Chapter 5
Chassis Modification & Construction



Tony Johnson illustration

Approval Record:

Signed in accordance with clause 1.3(5) of the Low Volume Vehicle Code of the LVVTA:	
On (date):.....by, on behalf of:	
the New Zealand Transport Agency:	Low Volume Vehicle Technical Association:
.....	.....

Amendment Record:

Detail of amendments:	**Issue date:**	**Effect date:**
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• 1st Amendment	November 2010	November 2010
• 2nd Amendment	June 2021	1 July 2021

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This NZ Car Construction Manual Chapter is published and owned by the Low Volume Vehicle Technical Association Incorporated (LVVTA). LVVTA is an incorporated society which was established in 1992, that represents a group of specialist automotive organisations (in turn representing approximately 150,000 members) who are dedicated to ensuring that vehicles, when scratch-built or modified, meet the highest practicable safety standards.

The information in this NZ Car Construction Manual Chapter has stemmed from work undertaken by LVVTA founding member organisations that commenced prior to 1990 and has been progressively developed as an integral part of New Zealand Government safety rules and regulations by agreement and in consultation with the New Zealand Transport Agency.

As a result, the considerable experience in applied safety engineering built up by LVVTA and the specialist automotive groups over the past several decades can be of benefit to members of the New Zealand public who also wish to build or modify light motor vehicles.

LVVTA's contact details are below:

- Postal address: P. O. Box 50-600, Porirua 5024, Wellington, New Zealand
- Website: www.lvvta.org.nz
- E-mail address: info@lvvta.org.nz

Availability & Current Version:

NZ Car Construction Manual Chapters are developed by the LVVTA, in consultation with the New Zealand Transport Agency, and are printed and distributed by the LVVTA. The Chapters are available to the public free of charge from the LVVTA website; www.lvvta.org.nz

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Users' Feedback:

This NZ Car Construction Manual Chapter is constantly undergoing an evolutionary development process in order to keep pace with changing trends and technology. To assist in this, LVVTA invites users of this Car Construction Manual Chapter to engage in an ongoing consultation process with us by making submissions for any changes, additions, or clarifications which might improve the Chapter, at any time.

Any submissions made via this rolling consultation process will be thoroughly considered, and incorporated, where appropriate, at the next available amendment opportunity.

Submissions should be made to submission@lvvta.org.nz, with the name of this Chapter in the Subject line.

Supporting Information:

This NZ Car Construction Manual Chapter is supported by a lot of other documents (referred to as 'supporting information' on the same subject, which could be very helpful to someone using this chapter.

This supporting information relating to this Chapter can be accessed from www.lvvta.org.nz/nzccm and is all free of charge.

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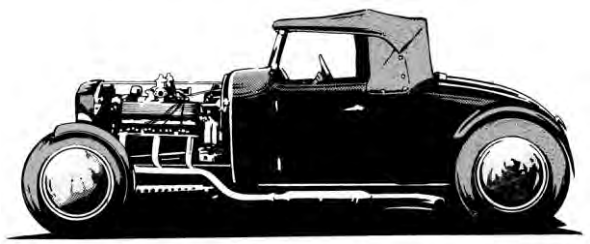
Credits:

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- CAD diagrams: Graham Walls
- Authorship & artwork: Tony Johnson
- Technical content: New Zealand Hot Rod Association (inc), LVVTA Technical Staff, LVVTA Technical Advisory Committee

Type Key: (For full details of Text Key, refer to Chapter 2 – About this Manual)

Normal type:	Provisions of the NZ Car Construction Manual for all vehicles.
Normal type in shaded box:	Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates.
Script type:	Helpful hints, tips, explanations, clarifications, and interpretations.
Grey shaded text & grey vertical stroke in margin:	Latest amendments since previous version. Note that text which is high-lit in grey shows amendments that have been made since the document's previous version, and a grey vertical stroke to the left of the text denotes new or changed information which is important (rather than just a grammatical, formatting, or numbering change).



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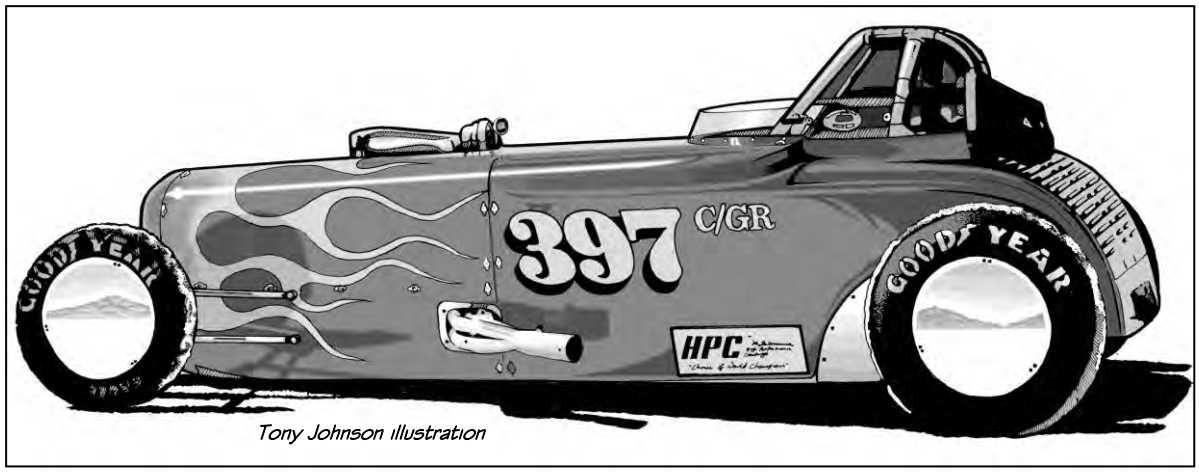
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Tony Johnson illustration

CHAPTER 5: CHASSIS MODIFICATION & CONSTRUCTION

Introduction:

In most cases, the traditional ladder-style or space-frame chassis is the foundation of the hobby motor car. The chassis supports the body and all of the major mechanical components, and keeps those components in their correct relative positions while the vehicle is subjected to the many stresses and loads imposed by acceleration, braking, cornering - and of course, our famous New Zealand roads.

Three basic types of chassis are covered here:

- high-volume manufacturers' chassis that are modified; and
- the 'ladder' or 'cruciform' chassis which is typically a mostly flat platform, incorporating channel or RHS (box) section side rails, linked by transverse and/or diagonal cross-members; and
- the 'space-frame' style which typically uses numerous predominantly straight small-diameter thin-wall tubes arranged in a triangulated manner to achieve high rigidity with minimal weight.

More complex motor vehicle foundations, such as the composite 'tub', whilst touched on here, is such a science that it is generally beyond the scope of this Car Construction Manual. Note that the requirements in this chapter do not apply to an unmodified production chassis.

General safety requirements:

5.0 Requirements applicable to all vehicles

5.0.1

A low volume vehicle must:

(a) be designed and constructed using materials and components that are fit for their purpose; and

(b) be safe to be operated on the road.

5.0.1

This is from 2.3 of Part 2 of the LVV Code, which makes it clear that, regardless of what technical requirements are or are not in place, every vehicle certified to the LVV Code must be fit for its purpose, and must be safe.

5.0.2

The performance of a motor vehicle in relation to protecting occupants in a frontal impact collision must not be reduced below a safe tolerance of its state when manufactured or modified, by any factors, including corrosion, structural damage, material degradation, inadequate repair, the fitting of additional equipment, or the removal of equipment.

5.0.2

These are the applicable general safety requirements from the Land Transport Rule 32006 Frontal Impact 2001, which are required as part of this Chapter, reproduced here in the interest of convenience.

Production vehicle chassis modification requirements:

5.1 Production chassis joining

5.1.1

A production vehicle chassis in a low volume vehicle which incorporates any join, including as a result of a shortening process, or a lengthening process, must:

5.1.1

This is typically to accommodate an increase in either passenger compartment area or load carrying capacity.

(a) be, where practicable, angle-cut to increase the weld area; and

5.1.1(a)

60 degrees is generally considered the correct angle.

(b) incorporate new material of the same type, specification, and wall thickness; and

(c) in order to avoid stress concentration points, be reinforced at the join by the attachment of a section or sections of material similar in specification to the chassis, that either:

(i) in the case of lengthened chassis or a chassis which has a wall thickness of less than 3 mm, extends beyond each side of the join by a distance of no less than twice the height of the chassis section being lengthened; or

(ii) in all other cases, meets the same joint reinforcement requirements specified for a custom ladder chassis in 5.10.1;

5.1.1(d)

This additional support could be provided by the use of flat plates on all three faces of a C-channel section, or a snug-fitting smaller channel-section positioned on the inside.

and

(d) be joined and reinforced by welding in accordance with the welding requirements specified in 'Chapter 18 - Attachment Systems'.

A chassis modified before 1992 is not required to comply with 5.1.1, provided that after thorough inspection, no twisting, bending, bowing, or fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

5.1.2

A production vehicle chassis designed and used for commercial activities in a low volume vehicle must not be extended or lengthened in order to enable the vehicle to carry a load beyond the gross vehicle mass specified by the original vehicle manufacturer, unless individually approved by LVVTA on a case-by-case basis.

5.1.3

Welding of any steels in a low volume vehicle which have an ultimate tensile strength exceeding 440 MPa must, in addition to meeting the welding requirements specified in 'Chapter 18 - Attachment Systems', incorporate a welding process that is compatible with the specific grade of steel.

5.2 Additional cross-members to production chassis

5.2.1

An additional cross-member fitted to a production vehicle chassis in a low volume vehicle must:

(a) be manufactured from material having dimensions appropriate for its application; and

(b) have a wall thickness of either:

(i) not less than the wall thickness of the main chassis rails; or

(ii) not less than 2.0 mm (5/64").

A chassis modified before 1992 is not required to comply with 5.2.1, provided that after thorough inspection, no twisting, bending, bowing, or fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

5.2.2

A low volume vehicle fitted with a production vehicle chassis that was originally equipped with only transversely-mounted cross-members, must incorporate additional cross-members that are positioned diagonally to provide the chassis with some additional beaming and torsional support if either:

(a) the vehicle's performance characteristics have been significantly increased; or

(b) the vehicle has been converted from a beam-type front axle to an independent front suspension system.

5.1.3

Welding steels with a tensile strength of up to 440 MPa is generally an acceptable practice, provided that the method used is either MIG-welding or TIG-welding.

5.2

See the Useful Information section for more information about adding cross-members to a production chassis.

5.2.1

Additional cross-members can be RHS (rectangular hollow-section), channel, or tubular section.

5.2.2

Consideration should be given to 5.4.3, and also to 'Adding cross-members to production chassis' in the Useful Information section.

'Diagonally' does not necessarily mean spanning from one side of the chassis to the other, or that a full 'X' must be incorporated. A 'K'-member or other system can be used as long as the 'folding parallelogram' effect is somehow prevented.

In this context, 'beaming' means a longitudinal bending load (or 'sagging' throughout the length of the chassis), and 'torsion' means a rotational twisting load throughout the length of the chassis.

A chassis modified before 1992 is not required to comply with 5.2.2, provided that after thorough inspection, no twisting, bending, bowing, or fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

5.2.3

Welding of any steels in a low volume vehicle which have an ultimate tensile strength exceeding 440 MPa must, in addition to meeting the welding requirements specified in 'Chapter 18 - Attachment Systems', incorporate a welding process that is compatible with the specific grade of steel.

5.2.3

Welding steels with a tensile strength of up to 440 MPa is generally an acceptable practice, provided that the method used is either MIG-welding or TIG-welding.

5.3 Production chassis 'C'-notch modifications

5.3.1

A suspension 'C'-notch fitted to a production chassis on a low volume vehicle must be made from material specifications that are appropriate for the type and size of the vehicle chassis.

5.3.1

A 'C'-notch can significantly weaken the rear chassis section to which it is attached, if not designed and installed correctly.

Bolt-in chassis C-notches should not be used unless fully-welded to the chassis, and both the C-notch and the chassis have been suitably reinforced.

5.3.2

The area of the chassis on a low volume vehicle at, and adjacent to, a 'C'-notch, must be suitably reinforced in order to reinstate the strength and rigidity lost in that area of the chassis as a result of the modification.

5.3.3

Welding of any steels in a low volume vehicle which have an ultimate tensile strength exceeding 440 MPa must, in addition to meeting the welding requirements specified in 'Chapter 18 - Attachment Systems', incorporate a welding process that is compatible with the specific grade of steel.

5.3.3

Welding steels with a tensile strength of up to 440 MPa is generally an acceptable practice, provided that the method used is either MIG-welding or TIG-welding.

5.4 Cross-member attachment to production chassis

5.4.1

Additional cross-members and mounting brackets fitted to a production vehicle chassis in a low volume vehicle, except for in the case of a cross-member or mounting bracket which is used only to support the weight of the component, must be attached to the chassis rails in such a way as to spread the transfer of their load to the web of the chassis rail by either:

(a) incorporating a reinforcing plate between the cross-member or bracket that spans the full height of the chassis rail (see Diagram 5.1); or

5.4.1

See 'Cross-member attachment to production chassis' in the 'Useful information' section for some situations where the requirements specified in 5.4.1 do not have to be met.

(b) spanning the full height of the chassis rail (see Diagram 5.1); or

(c) in the case of an open C-section chassis rail, attaching the cross-member or bracket to a section of bridging material that spans the full height of the chassis rail, and:

(i) is manufactured from a material of an appropriate specification for the application; and

(ii) has a substantial radius at each point where the bridging material meets the chassis rail to avoid stress points and consequential fatigue cracking (see Diagram 5.2).

A chassis modified before 1992 is not required to comply with 5.4.1, provided that after thorough inspection, no twisting, bending, bowing, or fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

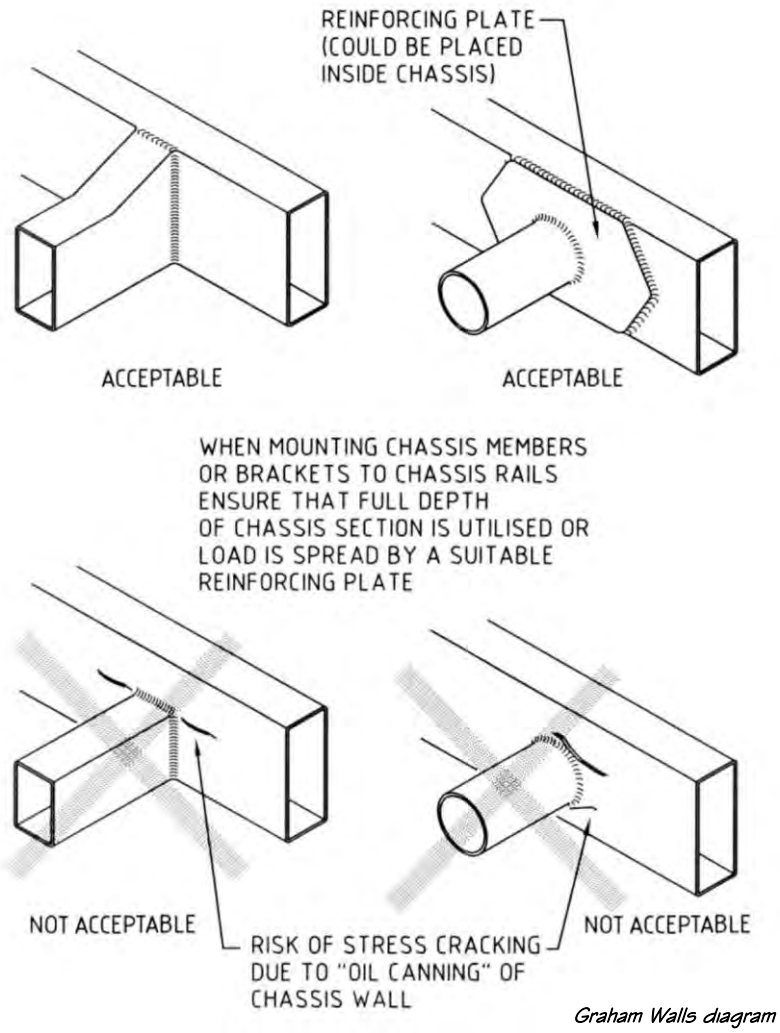


Diagram 5.1 Cross-member to chassis rail attachment

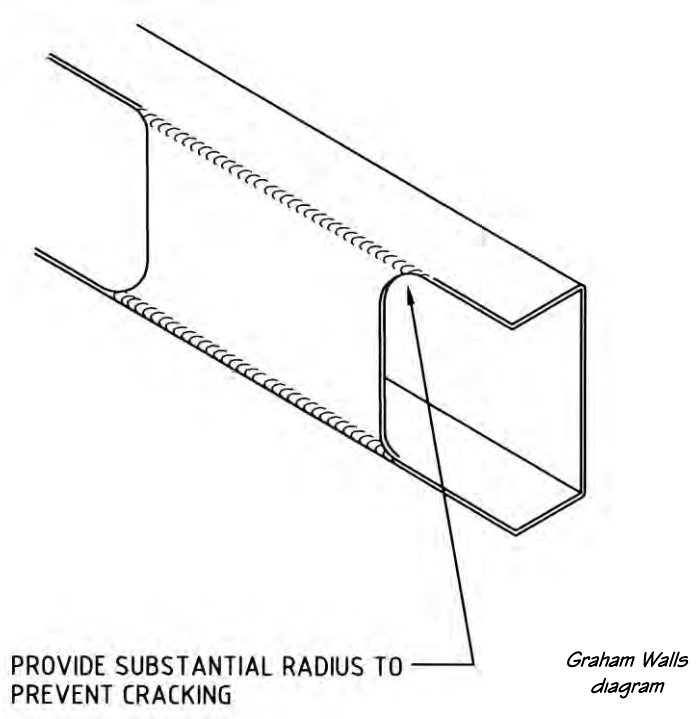
5.4.1

C-section type chassis rails may be partially boxed at locations to suit mounting of cross-members, brackets, engine mounts, etc, or to stiffen or strengthen the chassis rails at specific locations, such as the area around where the engine is mounted.

Diagram 5.1

The style of twin-tubular cross-member system shown in Diagram 5.5 is also an acceptable method of spreading the load across the full height of the chassis rail web.

Moisture-trapping cavities (inside which dust, dirt, and water can collect and then rust) should be avoided where possible.



Graham Walls diagram

Diagram 5.2 Cross-member to chassis rail attachment (radius)

Diagram 5.2

See the requirement specified in 5.4.1(c)(ii).

Moisture-trapping cavities (inside which dust, dirt, and water can collect and then rust) should be avoided where possible.

5.4.2

An additional cross-member fitted to a production vehicle chassis in a low volume vehicle must be attached by means of either:

(a) welding, that meets the requirements specified in 18.7 and 18.8 of 'Chapter 18 - Attachment Systems'; or

(b) bolting, that meets the requirements specified in 18.2 to 18.6 of 'Chapter 18 - Attachment Systems'; or

(c) rivets of a size and type suitable for their application, which pass through holes that are drilled for a close-tolerance fit.

5.4.3

This generally applies where a light truck was originally designed with open C-section chassis rails, with cross-members attached by rivets, and attached at the top and bottom flanges of the C-section to enable chassis flex, in which case additional members should not be welded into place but attached by the same method and in the same parts of the chassis, to avoid localised stiffening and fracturing of the chassis.

5.4.3

A production vehicle chassis used in a low volume vehicle designed and used for commercial activities, that has one or more chassis cross-members replaced, or is fitted with additional chassis cross-members, must have the replacement or additional cross-members attached to the chassis by a method that (see Diagram 5.3):

(a) replicates the method in which the original cross-members are attached; and

(b) duplicates the parts of the chassis rail to which the original cross-members are attached; and

(c) does not restrict or inhibit the working characteristics of the original chassis design.

A chassis modified before 1992 is not required to comply with 5.4.3, provided that after thorough inspection, no twisting, bending, bowing, or fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

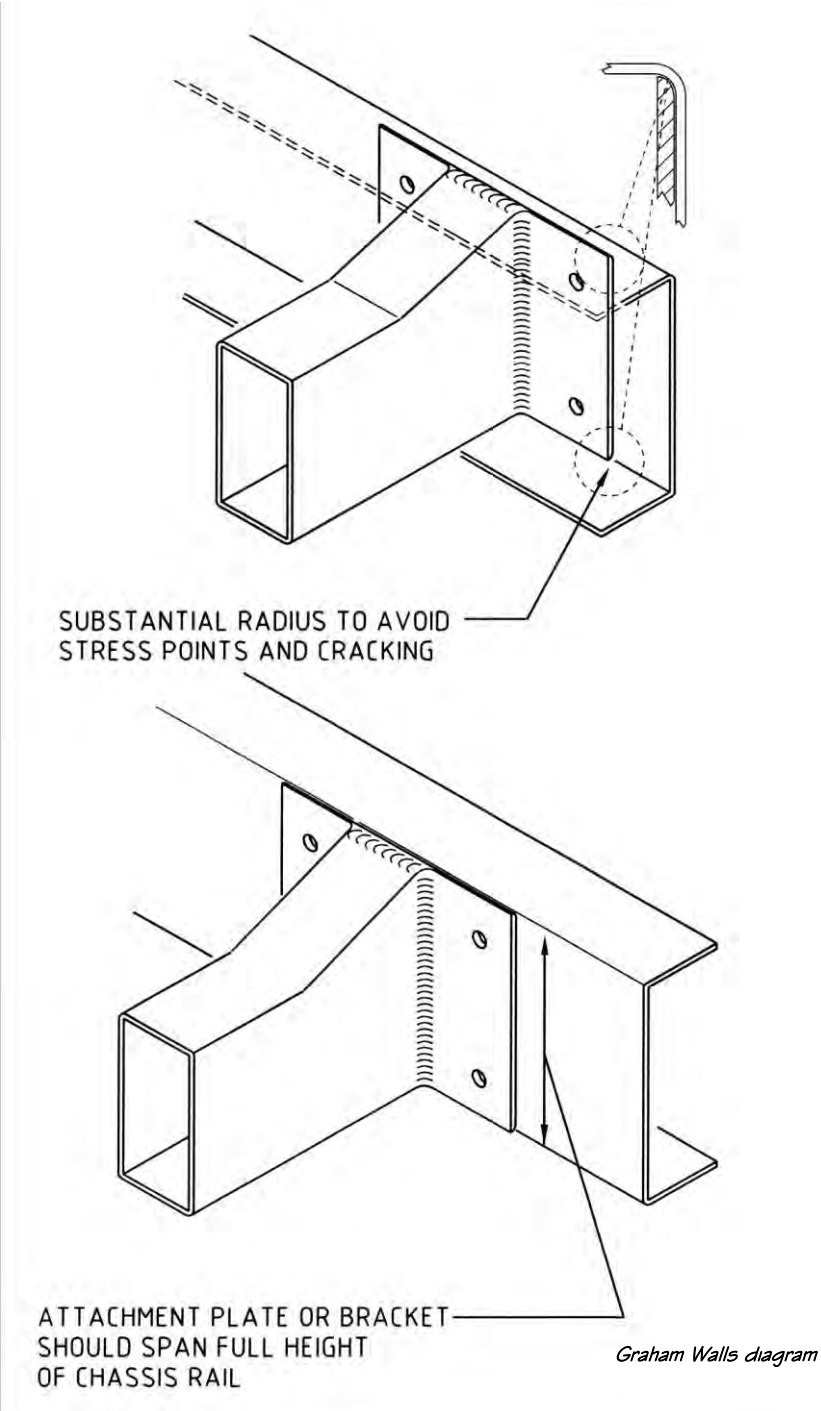


Diagram 5.3 Cross-member to C-section chassis attachment

Diagram 5.3

The radius referred to in the top diagram is to ensure that all of the edges (top, bottom, and sides) of the plate facing the chassis rail are chamfered to minimise edge loading or chafing. A chamfer or radius on the plate also ensures that the plate sits flat against the chassis rail sections, and prevents the plate edge creating a mis-match against the internal radius.

5.4.4 (see next page)

Welding steels with a tensile strength of up to 440 MPa is generally an acceptable practice, provided that the method used is either MIG-welding or TIG-welding.

5.4.4

Welding of any steels in a low volume vehicle which have an ultimate tensile strength exceeding 440 MPa must, in addition to meeting the welding requirements specified in 'Chapter 18 - Attachment Systems', incorporate a welding process that is compatible with the specific grade of steel.

5.4.4

See side-bar on previous page.

5.5 Production chassis torsional stiffness

5.5.1

A production chassis in a low volume vehicle that is fitted with a non-standard body must be properly assessed to ensure that the combination of the chassis and non-factory body exhibits not less than the same amount of torsional strength as the donor vehicle from which the body is sourced.

A chassis built before 1992 is not required to comply with 5.5.1, provided that after thorough inspection, no twisting, bending, bowing, or fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

5.5.1

See 'Torsional Strength' and 'Torsional Testing' in the 'Useful Information' section.

5.6 Production chassis frontal impact

5.6.1

A modified production chassis in a low volume vehicle must not:

(a) be modified in any way that, in the event of a frontal impact, could:

(i) result in increased deformation of the passenger compartment; or

(ii) increase the likelihood of penetration of the engine or transmission into the passenger compartment;

or

(b) feature any modifications that could affect the vehicle's frontal impact performance, including any crumple zone or other energy-absorbing measure incorporated by the vehicle manufacturer.

A vehicle which was manufactured before 1 March 1999 is not required to comply with 5.6.

5.6.1

This means that you can't do anything to stiffen a chassis between the front axle centre-line and the front of the vehicle, and should avoid wherever possible any stiffening between the front axle centre-line back to the firewall. Production vehicles are designed to deform under impact to absorb energy, thereby reducing the deceleration rate of the occupants, and this protection system must not be compromised, particularly by the addition of any longitudinally-positioned bars that could stiffen the front of the vehicle, such as roll-cage or roll-bar sections, suspension reinforcement bars, or other components that provide longitudinal stiffening forward of the front axle centre-line.

See also 'Exclusions' section for situations where compliance with 5.6.1 is not required.

See also 'Frontal impact performance of production vehicles' in the 'Useful Information' section.

Custom ladder chassis construction requirements:

5.7 Custom ladder chassis basic design

5.7.1

The design of a custom ladder chassis in a low volume vehicle must either:

(a) follow generally accepted time-proven design and construction methods and material specifications applicable to the project in question; or

(b) have been approved in writing through the process specified in 'Chapter 4 - Build Approval Process', by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc).

5.7.2

The section and wall thickness of material used for the construction of a custom ladder chassis in a low volume vehicle must be suitable for the vehicle's size, weight, and performance.

5.8 Custom ladder chassis main rail design

5.8.1

The main rails of a custom ladder chassis in a low volume vehicle must be manufactured from either:

(a) a material specification of not less than:

(i) in the case of RHS, 75 mm x 50 mm x 3 mm (3" x 2" x 1/8"); or

(ii) in the case of tubular section, 75 mm x 2 mm (3" x 5/64");

or

(b) a combination of materials that have been approved in writing through the process specified in 'Chapter 4 - Build Approval Process', by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc).

A chassis built before 1992 is not required to comply with 5.8.1, provided that after thorough inspection, no twisting, bending, bowing, or fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

5.7.1

Wherever ladder chassis are referred to, this includes cruciform and perimeter-type chassis also.

5.7.1(b)

The Technical Advisory Committee may require engineering calculations or torsional testing to be carried out if a proposed chassis design is well away from traditional types. As a generalisation, the build approval process is not a mandatory requirement, however it can provide good assurance to the constructor that his or her ideas are sound, thereby reducing the chances of major problems during the certification inspection.

5.8.1

This minimum material specification does not apply to the area of the chassis in front of the forward-most front suspension attachment points. A 'suspension pick-up point', for the purpose of this requirement, means a primary suspension component used to locate the hub assembly.

5.8.1(a)

This specification is a minimum, intended more for a light-weight vehicle. See the 'Ladder Chassis Material Specifications' part of the 'Useful Information' section.

5.8.2

The main rails of a channel-section custom ladder chassis in a low volume vehicle must either:

(a) be fully boxed; or

(b) at locations where high loads could be transmitted to the chassis from the engine mounting, suspension pick-up points, or cross-member attachment points:

(i) be partially boxed in the loaded areas; or

(ii) be reinforced in the loaded areas in accordance with the requirements specified in 5.9.1.

A chassis built before 1992 is not required to comply with 5.8.2, provided that after thorough inspection, no twisting, bending, bowing, or fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

5.9 Custom ladder chassis cross-member attachment

5.9.1

Cross-members and mounting brackets must be attached to the main rails of a custom ladder chassis in a low volume vehicle in such a way as to spread the transfer of their load to the web of the chassis rail by either:

(a) spanning the full height of the chassis rail (see Diagram 5.1); or

(b) incorporating a reinforcing plate between the cross-member or bracket that spans the full height of the chassis rail (see Diagram 5.1); or

(c) in the case of an open C-section custom ladder chassis rail, attaching the cross-member or bracket to a section of bridging material that spans the full height of the chassis rail, that (see Diagram 5.2):

(i) is manufactured from a material of an appropriate specification for the application; and

(ii) has a substantial radius at each point where the bridging material meets the chassis rail to avoid stress points and consequential fatigue cracking.

A chassis built before 1992 is not required to comply with 5.9.1, provided that after thorough inspection, no twisting, bending, bowing, or fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

5.8.2

Unboxed C-section type chassis rails are particularly weak under torsional loads (twisting), so for high-performance applications, full-boxing is ideal, but at the very least C-section rails should be partially-boxed at locations to suit mounting of cross-members and engine mounts, to stiffen or strengthen the chassis rails at specific locations, such as where the engine is mounted.

See also 'Ladder chassis material specifications' in 'Useful Information' section.

Note that all chassis welds must comply with the requirements specified in 18.9.1 of 'Chapter 18 – Attachment Systems', which specifies that a weld cannot be ground, dressed, smoothed, or covered with filler.

For a commercial vehicle with a C-section chassis, refer to sidebar note 5.4.3.

5.10 Custom ladder chassis join reinforcement

5.10.1

Where sections of a custom ladder chassis in a low volume vehicle positioned between the front and rear axles or suspension pick-up points are joined by welding, some additional form of reinforcement or gusseting must be provided at each section join, which:

(a) must not be less than 3 mm thickness, or not less than the thickness of the chassis rail web; and

(b) may be either:

(i) capping plates on the top and bottom of the chassis rails (see Diagram 5.4); or

(ii) fish-plates positioned on one side of the chassis rail, which can be either the outside or the inside of the chassis rail (see Diagram 5.4); or

(iii) a cross-member or permanent roll-cage section positioned in such a way that it overlaps the join, and assists in load distribution (see Diagram 5.4).

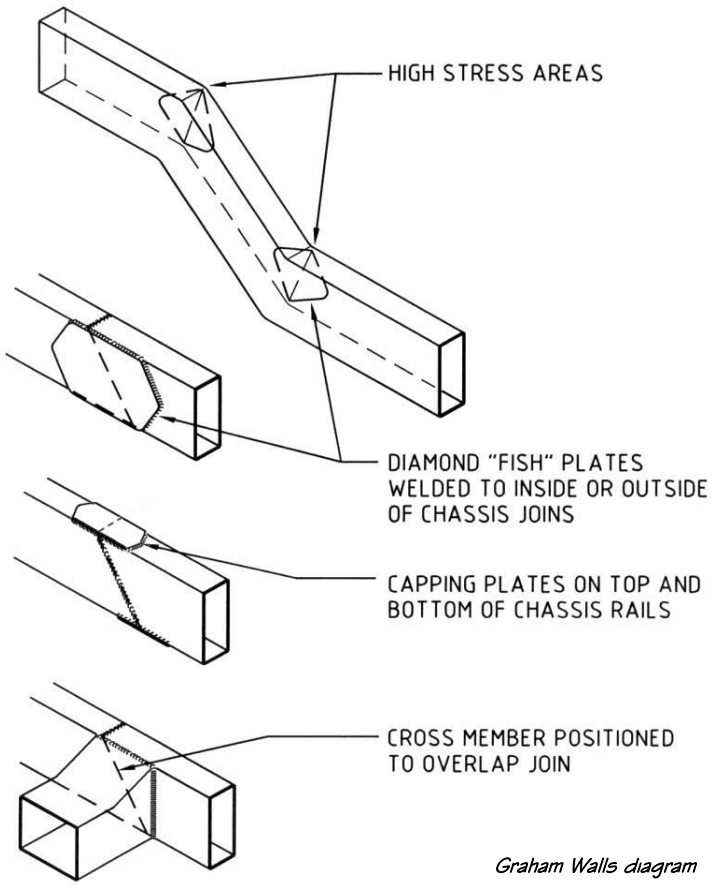


Diagram 5.4 Chassis joint reinforcement

5.10.1

Chassis joins should, where possible, be angle-cut to increase the length of weld area.

5.10.1(a) & (b)

Plates specified in 5.10.1(a) or (b) may be fitted on the inside of the chassis rails if a clean look is desired, provided that the LVV Certifier has either inspected the plate installation prior to the boxing being carried out, or can confirm the presence of the plates from the outside of the chassis section (from heat marks) before the rail sections are cleaned up and coated.

Diagram 5.4

All fish-plates and capping plates should incorporate some 'diamond' shape, or curvature, into them, so as to avoid stress concentrations.

A chassis built before 1992 is not required to comply with 5.10.1, provided that after thorough inspection, no twisting, bending, bowing, or fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

5.11 Custom ladder chassis torsional stiffness

5.11.1

A custom ladder chassis in a low volume vehicle must incorporate cross-members that are designed and positioned in such a way as to provide the chassis with sufficient resistance to torsional twisting movement (see Diagram 5.5).

5.11.1

The type of cross-member arrangement should be suitable for the application, taking into account the type of suspension, vehicle weight, and engine horsepower.

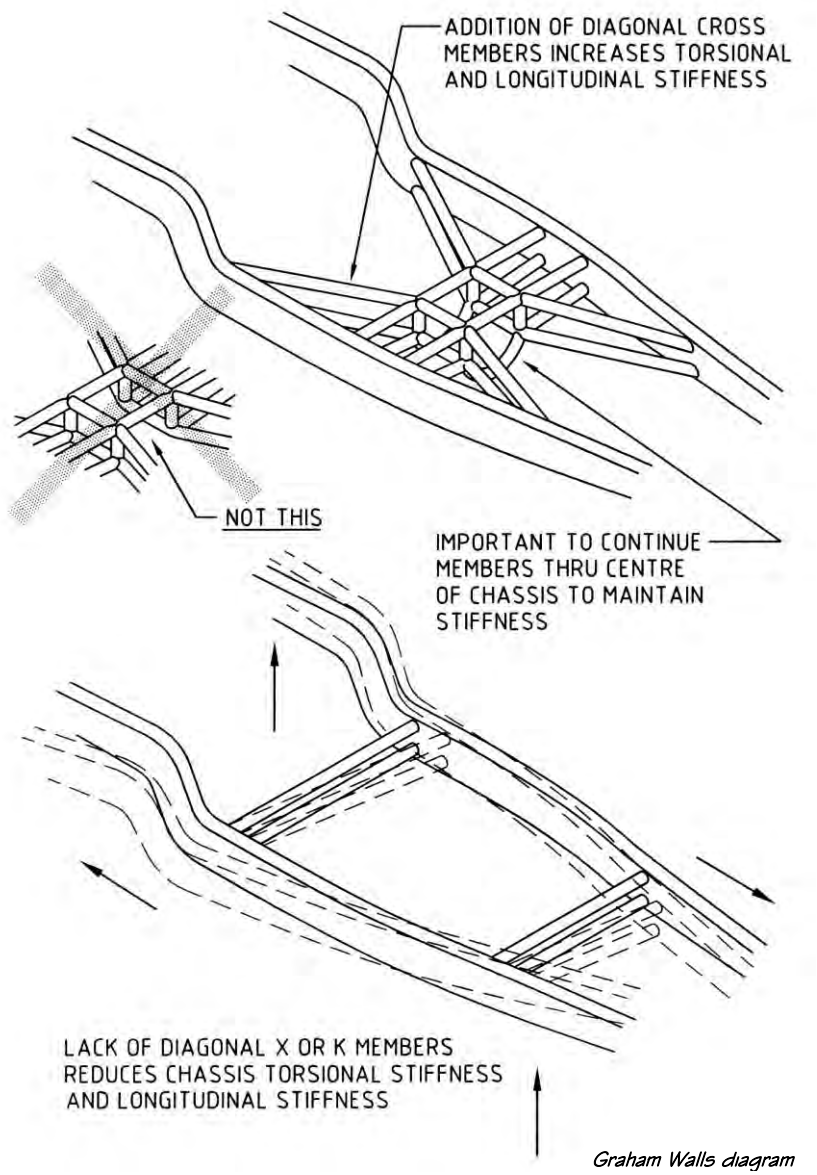


Diagram 5.5 Chassis rail torsional stiffness

A chassis built before 1992 is not required to comply with 5.11.1, provided that after thorough inspection, no twisting, bending, bowing, or fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

5.12 Custom ladder chassis frontal impact

5.12.1

A custom ladder chassis in a low volume vehicle must be constructed in such a way as to:

(a) minimise the likelihood of penetration of the engine, transmission, suspension, body structure or parts into the passenger compartment as a result of a frontal impact; and

(b) ensure that the section of the vehicle forward of the passenger compartment will progressively absorb impact energy without significant deformation of the passenger compartment, either by:

(i) featuring design characteristics forward of the passenger compartment comparable with that expected of same-era mass-produced vehicles; or

(ii) following relevant design and construction principles specified in 5.12.2.

A custom ladder chassis which was constructed before 1 March 1999 is not required to comply with 5.12.1

5.12.2

In addition to 5.12.1, a custom ladder chassis in a low volume vehicle must feature a purpose-designed reduction in longitudinal stiffness, in the area of the chassis in front of the forward-most front suspension attachment point, by a method which may include:

(a) the use of a chassis material which has a lesser wall thickness than the primary chassis rail sections; or

(b) the use of a chassis material which has less rigidity than the primary chassis rail sections; or

(c) the positioning of a change in direction of the chassis rails, which has the effect of tapering the chassis rail sections inward or outward from the direct longitudinal direction; or

(d) the incorporation of failure or deformation points, through appropriately positioned holes, slots, or cut-aways.

5.12.1

Production vehicles are designed to deform under impact to absorb energy, thereby reducing the deceleration rate of the occupants. This principle must be applied as far as is practicable to custom chassis and scratch-built vehicles. This means that a chassis must not be designed to be any stiffer than it needs to be between the firewall and the front of the vehicle, particularly between the front axle centre-line and the forward-most part of the vehicle, other than fulfilling the functions required of it, such as supporting the various components and body section attached to it. This could be achieved through the use of channel section at the front of an RHS chassis.

See 'Exclusions' section for situations where compliance with 5.12.1 is not required.

5.12.1(b)(i)

This means, basically, that if an original Model-A Ford chassis is made from 3 mm (1/8") wall material, use a lighter material at the forward section of the reproduction chassis, or alternatively, don't 'box' this area of the chassis (leave as a 'C-section').

5.12.2

Stiffness reduction forward of the suspension is to avoid affecting a vehicle's safe operation.

A custom ladder chassis which was constructed before 1 March 1999 is not required to comply with 5.12.2

Custom space-frame chassis construction requirements:

5.13 Custom space-frame chassis basic design

5.13.1

The design of a custom space-frame chassis in a low volume vehicle must either:

(a) follow generally accepted time-proven design and construction methods and material specifications applicable to the project in question; or

(b) have been approved in writing through the process specified in 'Chapter 4 - Build Approval Process', by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc).

5.14 Custom space-frame chassis design requirements

5.14.1

The diameter and wall thickness of tubing used for the construction of a custom space-frame chassis in a low volume vehicle must:

(a) be suitable for the size, weight, and performance potential of the vehicle; and

(b) be manufactured from a material specification of either:

(i) not less than 1.6 mm (1/16") in wall thickness for any major chassis component; or

(ii) a combination of materials that have been approved in writing through the process specified in 'Chapter 4 - Build Approval Process', by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc).

A chassis built before 1992 is not required to comply with 5.14.1, provided that after thorough inspection, no twisting, bending, bowing, or fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

5.12.2

A 'forward-most front suspension attachment point', for the purpose of this requirement, means a primary suspension component which is used to locate the hub assembly.

5.13

A typical example of a space-frame chassis is that found on a Lotus 7 sports car.

5.13.1(b)

The Technical Advisory Committee may require engineering calculations or torsional testing to be carried out if a proposed chassis design is well away from traditional types. Although the build approval process is not a mandatory requirement for a time-proven design, the process can provide good assurance to the constructor that his or her ideas are sound, thereby reducing the chances of major problems or disappointments at certification time.

5.14.1(b)(i)

This minimum material specification does not apply to the area of the chassis in front of the forward-most front suspension attachment points.

5.14.2

A custom space-frame chassis in a low volume vehicle must incorporate sufficient depth between the top and bottom main frame rails to provide the necessary frame rigidity in order to resist the applied combined torsional and beaming loads.

5.14.2

'Torsional' in this context means rotational twisting loads throughout the length of the chassis, and 'beaming' means bending loads (sagging) on the horizontal plane throughout the length of the chassis.

The material specification of the main frame rails must be increased accordingly if the depth between the rails is decreased, such as where the rails run below opening doors, if opening doors are incorporated within the vehicle design.

5.14.3

A custom space-frame chassis in a low volume vehicle must incorporate triangulated bracing within all load-bearing sections of the chassis except for:

(a) the areas forward of the front suspension, and rearward of the rear suspension; and

(b) where physical constraints prevent the placement of triangulated bracing, in which case the same rigidity is required to be achieved in such areas through the use of an alternative method of bracing.

A chassis built before 1992 is not required to comply with 5.14.3, provided that after thorough inspection, no twisting, bending, bowing, or fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

5.14.3(b)

An example of an alternative method of bracing is a diaphragm panel attached across the opening by bonding and riveting.

5.15 Custom space-frame chassis component attachment

5.15.1

Brackets and anchorage points used to attach components to a custom space-frame chassis in a low volume vehicle that could substantially load the chassis, such as suspension, engine, steering, brakes, and seatbelt anchorages must be attached (see Diagram 5.6):

(a) either:

(i) at points where no less than two chassis tubes intersect; and

(ii) where sufficient gusseting is incorporated to maximise the area of frame throughout which the loads applied by the components are spread;

or

(b) at a location where it can be proven that the chassis has sufficient strength to support the loadings that could be transmitted to it without failure or deformation.

5.15.1(b)

'Proven' could include comparisons with equivalent proven designs, or through confirmation established by an engineering calculation process by a suitably experienced heavy vehicle certifier.

A chassis built before 1992 is not required to comply with 5.15.1, provided that after thorough inspection, no fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

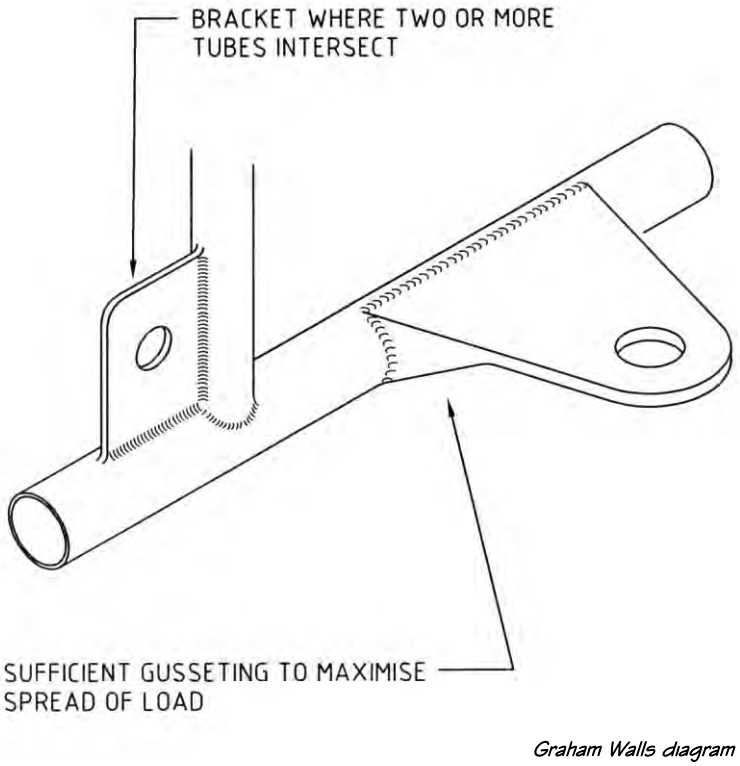
5.15.2

Component attachment brackets welded to the chassis tubes within a custom space-frame chassis in a low volume vehicle, must be welded in such a way as to:

(a) reduce the effect of the stress concentration point; and

(b) ensure that a site for corrosion is not created between the bracket and the tube.

A chassis built before 1992 is not required to comply with 5.15.2, provided that after thorough inspection, no corrosion is evident. Specific investigation for corrosion must be carried out, with removal of paint if necessary to assist the inspection process.



Graham Walls diagram

Diagram 5.6 Custom space-frame component attachment

5.15.2(b)

A continuous weld around the bracket is a common way of avoiding a corrosion site.

5.16.1 (next page)

The type of chassis tube placement and cross-member arrangement should be suitable for the application, taking into account the type of suspension, vehicle weight, and engine horsepower.

5.16 Custom space-frame chassis torsional stiffness

5.16.1

A custom space-frame chassis in a low volume vehicle must incorporate chassis tubes that are designed and positioned in such a way as to provide the chassis with sufficient resistance to torsional twisting movement.

A chassis built before 1992 is not required to comply with 5.16.1, provided that after thorough inspection, no twisting, bending, bowing, or fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

5.17 Custom space-frame chassis frontal impact

5.17.1

A custom space-frame chassis in a low volume vehicle must be constructed in such a way as to:

(a) minimise the likelihood of penetration of the engine, transmission, suspension, body structure or parts into the passenger compartment as a result of a frontal impact; and:

(b) ensure that the section of the vehicle forward of the passenger compartment will progressively absorb impact energy without significant deformation of the passenger compartment, either by:

(i) featuring design characteristics forward of the passenger compartment comparable with that expected of same-era mass-produced vehicles; or

(ii) following relevant design and construction principles specified in 5.17.2.

A custom space-frame chassis which was constructed before 1 March 1999 is not required to comply with 5.17.1.

5.17.2

A scratch-built custom space-frame chassis in a low volume vehicle must, in addition to 5.17.1, feature a purpose-designed reduction in longitudinal stiffness, in the area of the chassis at the front of the forward-most suspension attachment point, which may include:

(a) the use of a chassis material which has a lesser wall thickness than the primary chassis rail sections; or

5.16.1

See the side-bar note on previous page.

5.17.1

Production vehicles are designed to deform under impact to absorb energy, thereby reducing the deceleration rate of the occupants. This principle must be applied as far as is practicable to custom chassis and scratch-built vehicles. This means that a chassis must not be designed to be any stiffer than it needs to be between the firewall and the front of the vehicle, particularly between the front axle centre-line and the forward-most part of the vehicle, other than fulfilling the functions required of it, such as supporting the various components and body section attached to it.

See 'Exclusions' section for situations where compliance with 5.17.1 is not required.

5.17.2

Stiffness reduction forward of the suspension is to avoid affecting a vehicle's safe operation.

A 'forward-most front suspension attachment point', for the purpose of this requirement, means a primary suspension component which is used to locate the hub assembly.

(b) the use of a chassis material which has less rigidity than the primary chassis rail sections; or

(c) the positioning of a change in direction of the chassis rails, which has the effect of tapering the chassis rail sections inward or outward from the direct longitudinal direction; or

(d) the incorporation of failure or deformation points, through appropriately positioned holes, slots, or cut-aways.

A custom space-frame chassis which was constructed before 1 March 1999 is not required to comply with 5.17.2.

5.17.2(b)

This could be achieved through the use of smaller diameter or thinner wall thickness tubing.

Composite chassis construction requirements:

5.18 Composite chassis basic design

5.18.1

A composite chassis, or section of a composite chassis, in a low volume vehicle, to which steering, suspension, braking, seats, seatbelts, or other highly-loaded or critical components attach, must be proven to have equal or greater strength and load-carrying capacity to a chassis using conventional chassis design and materials, taking into consideration the vehicle's weight, performance characteristics, and intended use.

5.18.2

The design of a composite chassis, or section of a composite chassis, in a low volume vehicle, must have been approved in writing through the process specified in 'Chapter 4 – Build Approval Process' by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc), who may at their discretion, require the involvement of outside expertise.

5.18

Composite materials can include fibre-glass, carbon-fibre, aluminium sandwich panel, or any other combination of structural materials.

The requirements specified here for a composite chassis also apply to any highly-loaded sections of a composite body. Also, any highly-loaded sections of a monocoque or unitary-constructed vehicle must be treated in the same way.

5.18.1 & 5.18.2

'Proven' and 'outside expertise' could include, as directed by the TAC, comparisons with equivalent proven designs, confirmation established by an engineering calculation process by a suitably experienced transport engineer, pull-testing, torsional testing, core sample testing, or any appropriate combinations thereof.

5.19 Composite chassis strength

5.19.1

The outer surface of a composite chassis, or section of a composite chassis, in a low volume vehicle, must be of sufficient strength and rigidity to resist penetration of foreign matter such as road debris during normal use.

5.19.1

This is especially relevant to the floor area. Such resistance should be at least equivalent to a normal panel steel floor-pan in a production vehicle.

5.19.2

A composite chassis, or section of a composite chassis, in a low volume vehicle, that uses ultra-high modulus carbon, must incorporate an extra level of protection by either:

(a) the use of a protective impact-resistant outer-coating, such as an aramid-ply; or

(b) the partial incorporation of a tough material such as a hybrid weave to act as a fail-safe; or

(c) including a sacrificial portion of the chassis or chassis section that will clearly fail first, with such a failure unable to cause any loss of braking or directional control of the vehicle.

5.19.2

'Ultra-high modulus carbon is known as 'UHMC'. Impact damage referred to here could include road debris.

5.19.2(a)

'Aramid-ply' is the generic name for what we know as 'Kevlar'.

5.20 Composite chassis torsional stiffness

5.20.1

A composite chassis in a low volume vehicle must be designed and constructed in such a way as to provide the chassis with sufficient resistance to torsional twisting movement.

5.20.1

The torsional stiffness of a composite chassis will require assessment and approval by the Technical Advisory Committee of the Low Volume Vehicle Technical Association.

A chassis built before 1992 is not required to comply with 5.20.1, provided that after thorough inspection, no twisting, bending, bowing, or fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

5.21 Composite chassis frontal impact

5.21.1

A composite chassis in a low volume vehicle must be constructed in such a way as to:

(a) minimise the likelihood of penetration of the engine, transmission, suspension, body structure or parts into the passenger compartment as a result of a frontal impact; and:

(b) ensure that the section of the vehicle forward of the passenger compartment will progressively absorb impact energy without significant deformation of the passenger compartment.

5.21.1

The frontal impact performance design of a composite chassis will require assessment and approval by the Technical Advisory Committee of the Low Volume Vehicle Technical Association.

A composite chassis which was constructed before 1 March 1999 is not required to comply with 5.21.1.

5.22 Composite chassis sealing

5.22.1

All edges within a composite chassis, or section of a composite chassis, in a low volume vehicle, must be fully sealed with a resin or other durable substance to prevent entry of moisture into the material.

5.22.1

Some composite materials are susceptible to osmosis, and must be properly sealed to prevent moisture from getting into the material structure. These materials can also be damaged if moisture becomes trapped in the material and freezes.

5.23 Composite chassis inspection

5.23.1

Resin or adhesive used during the moulding or connections of a composite chassis, or section of a composite chassis, in a low volume vehicle, must be shown to be fully bonded and cured, by retaining and providing to the LVV Certifier, either:

(a) core sample cut-outs of the main structure; or

(b) representative samples of each composite material used in the manufacture of the main structure, made identically and simultaneously with the main composite mouldings or structures.

A chassis built before 1992 is not required to comply with 5.23.1, provided that after thorough inspection, no delamination is evident. Specific investigation for delamination must be carried out, with removal of paint if necessary to assist the inspection process.

5.23.1

Signs of delamination can often be identified through a simple 'tap-test'; - using the edge of a coin, a sharp 'tap' sound suggests a sound bond, whereas a dull 'thud' is an indicator of delamination.

5.23.1(b)

The requirement for representative samples includes any connection of any composite materials.

Additional requirements for all chassis modification & construction:

5.24 Chassis reinforcement

5.24.1

A chassis bracket designed for the attachment of a critical steering or braking component in a low volume vehicle, where the attachment relies on a weld, must incorporate some form of additional reinforcement or gusseting.

A chassis built before 1992 is not required to comply with 5.24.1, provided that after thorough inspection, no fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

5.25 Engine and drive-train attachment

5.25.1

The engine and drive-train fitted to a low volume vehicle must be attached to the chassis in accordance with the requirements specified in 'Chapter 9 - Engine & Drive-train'.

5.26 Cross-member, bracket, and component attachment

5.26.1

A suspension or steering attachment point must be positioned on a modified or custom chassis in a low volume vehicle in such a way that any irregularities within the chassis caused by distortion during the chassis modification or manufacturing process, and could result in adverse suspension or steering geometry, are compensated for.

5.26.1

If a chassis twists through heat during welding, exactly symmetrical placement of brackets may be 'out of square', and cause the suspension or steering geometry to be out when the vehicle is completed.

5.26.2

A fastener which attaches structural sections, brackets, or mechanical components to RHS, channel, or tubular chassis rails or cross-members in a low volume vehicle, must pass through a tubular steel reinforcing crush-tube that:

(a) is manufactured of a material with a wall thickness of not less than the material used for the main chassis rails or cross-members, however in no circumstances less than 3 mm; and

(b) is of an inside diameter that provides a close tolerance fit for the fastener; and

(c) is inserted within the chassis rail or cross-member through a hole that provides a close tolerance fit for the reinforcing crush-tube, on the face of the chassis rail or cross-member opposite to that which the component is positioned against; and

(d) is fully welded to the face of the chassis rail or cross-member opposite to that which the component is positioned against (see Diagram 5.7).

5.26.2

A crush-tube prevents crushing and collapsing of the chassis or cross-member section, which in turn prevents the fastening system from loosening.

5.27 Drive-shaft safety-loops

5.27.1

A drive-shaft safety-loop must be fitted to those low volume vehicles specified in 'Chapter 9 - Engine & Drive-train'.

5.27.1

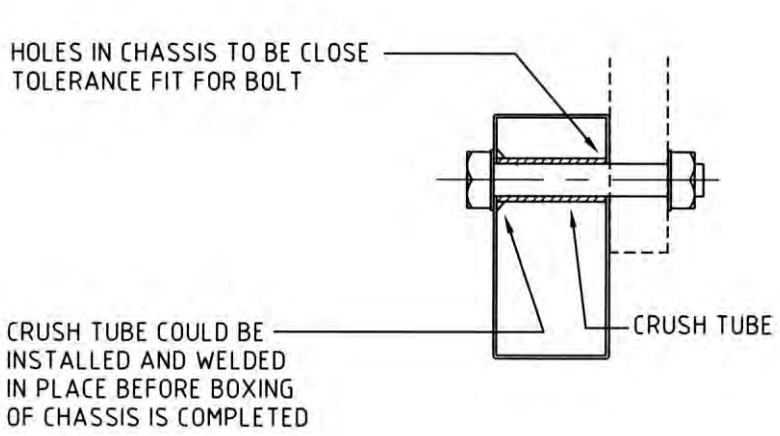
Chapter 9 – Engine & Drive-train sets out all of the modification and construction situations where a drive-shaft safety-loop is required.

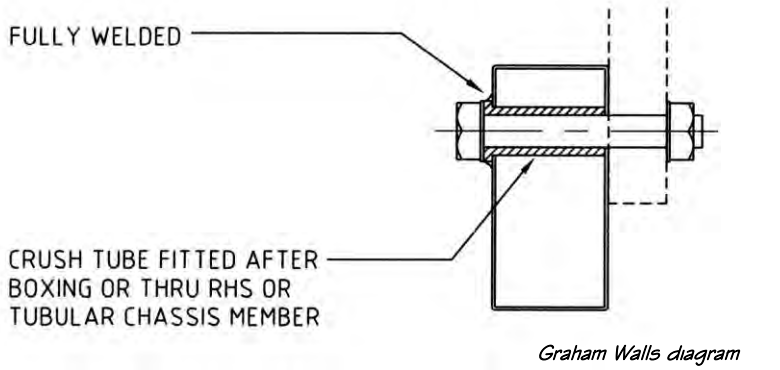
5.27.2

A drive-shaft safety-loop fitted to a low volume vehicle must meet all requirements, including design, construction, positioning, and attachment specified in 'Chapter 9 - Engine & Drive-train'.

5.27.2

A lot of good information about how to correctly make and install drive-shaft safety-loops is provided in Chapter 9 – Engine & Drive-train.





Graham Walls diagram

Diagram 5.7 Crush-tube installation

Diagram 5.7

The top example shown in Diagram 5.7 illustrates where capped (or boxed) C-section material is used, and a crush-tube is positioned and tack-welded before the capping plate is welded on.

5.28 Body mounts

5.28.1

A low volume vehicle fitted with a body separate from its chassis must incorporate mounts within the chassis for the attachment of the body, of a design, size, and number:

(a) in the case of a modified production vehicle, not less than that provided by the original vehicle manufacturer; and

(b) in the case of a modified production vehicle which has the passenger compartment space extended or lengthened, the number of chassis attachment points must be increased in direct proportion to the passenger compartment extension to provide a consistent or increased ratio of mounting points to passenger compartment size; and

(c) in the case of a scratch-built replica vehicle, not less than that used by the original vehicle being replicated; and

(d) in the case of a scratch-built vehicle that is not a replica, sufficient fasteners to retain the body to the chassis in the event of a 20g deceleration.

5.28.1 (a) and (c)

This would not apply in a situation where the modified or newly-constructed vehicle has seatbelts attached to the body structure, and the modified or replicated vehicle was never designed to be fitted with seatbelts. In this case, 5.25.1 (d) applies.

5.28.1 (d)

A 'g' figure is the mass (weight) multiplied by a pre-determined acceleration – in this case the vehicle's body weight x 20g (the maximum likely survivable crash deceleration weight). See the 'Useful Information' section of 'Chapter 18 - Attachment Systems' for a hitch-hiker's guide to this subject.

5.29 Chassis welding

5.29.1

All welding incorporated within a chassis on a low volume vehicle must meet all welding requirements specified in 18.7 and 18.8 of 'Chapter 18 - Attachment Systems'.

5.30 Chassis fasteners

5.30.1

All fasteners incorporated within a chassis on a low volume vehicle must meet all fastening requirements specified from 18.2 to 18.6 inclusive in 'Chapter 18 - Attachment Systems'.

5.30.2

In addition to 5.30.1, fasteners that attach cross-members, brackets, or spring hangers, that are under, or transmit, high loadings within any chassis modification or construction in a low volume vehicle, must pass through holes that are drilled for a close-tolerance fit.

5.31 Condition

5.31.1

All areas within a production chassis of a low volume vehicle that have been modified, and all areas of a custom chassis in a low volume vehicle, must:

(a) be protected against corrosion; and

(b) not have any rust, corrosion, cracking, or any other kind of damage, to the extent that the chassis may be weakened as a result; and

(c) where the chassis is not readily visible when fitted with its body panels, be inspected by a Low Volume Vehicle Certifier prior to being fitted with the outer body panels.

5.31.1(c)

This is particularly relevant in the case of a space-frame chassis, which is often fully enclosed by riveted body panels.

5.32.1

This means that a vehicle built or modified before March 1999 is not required to meet frontal impact requirements.

5.33.1 (next page)

This enables the fitment of typical items that are required for motor-sport purposes, but have the effect of stiffening a forward structure, such as sump-guards, forward roll-bar sections, and suspension strut braces.

Note that motor-sporting regulations require the use of additional occupant protection measures to compensate for these structural modifications.

Exclusions:

5.32 Design criteria exclusions

5.32.1

A low volume vehicle that was originally manufactured before 1 March 1999 is not required to comply with 5.6, 5.12, or 5.17.

5.33 Motor-sport use exclusions

5.33.1

A low volume vehicle, for which a valid MotorSport New Zealand Authority Card that specifies Frontal Impact is issued, is not required to comply with 5.6, 5.12, or 5.17.

5.34 All-terrain vehicle exclusions

5.34.1

Scratch-built four-wheel drive all-terrain vehicles designed and constructed to be operated in conditions, and for uses, which would make the incorporation of an energy-absorbing frontal section impractical, are not required to meet 5.6, 5.12, or 5.17.

5.34.1

This provides the ability for military-type assault vehicles, or serious-duty off-road vehicles to be constructed without frontal impact protection where the vehicle's design and intended use makes such protection impractical.

Useful information:

Adding cross-members to production chassis (refer to section 5.2)

There is a general view that when converting a vehicle which was originally equipped with a beam-type front axle to an independent front suspension (IFS), that – because of the greater loads that an IFS applies to a chassis over a beam-type axle – additional cross-members should be fitted to the chassis to support these additional loadings. This view is reflected in 5.2.2.

There are however certain chassis types where this requirement is not always appropriate, such as a 1950's American pickup or other vehicle type designed for commercial activities such as those in 5.4.3. Where an IFS conversion occurs in these commercial vehicles, particularly where a relatively low-powered small-block V8 engine is used, additional crossmembers may not be necessary.

Constructors should keep in mind however that without the torsional improvements that additional or better cross-members will bring, the vehicle will not achieve anywhere near the expected benefits from the IFS upgrade due to that chassis flex that will still exist, as a result of the inherent chassis design. Fully boxing the chassis and adding suitable cross-members and diagonal members is preferred when higher-powered engines are being used, or when improved cornering, road-holding, or general chassis performance is desired.

Cross-member attachment to production chassis (refer to section 5.4)

The requirements specified in 5.4.1 are primarily aimed at those cross-members and mounting brackets attaching an engine, or locating the vehicle's suspension system. In some situations, a cross-member or mounting bracket is neither designed nor required to transmit torsional loadings between chassis rails, but is simply supporting the weight of the gearbox or other component like a fuel tank. There are many OEM examples of this; for example, gearbox cross-members attached to the underside of the chassis rail, or to brackets attached to the side of the chassis rails.

Where a cross-member or mounting bracket is only supporting the weight of the component, and no engine torque, or chassis torsional loads will be transmitted, there is no risk of oil-canning, and therefore the requirements specified in 5.4.1 may be relaxed, provided fit-for-purpose mounting and attachment practices are incorporated.

Another situation where the attachment system specified in 5.4.1 is not necessary is the situation where two tubes are positioned one above the other against the chassis rail to create a 'dual-plane' cross-member system - provided of course that the tubes are positioned as far apart (vertically) as practicable. Sometimes, some 'staggering' of the top-to-bottom tube attachments points on the chassis rail is necessary, but this should be kept to a minimum.

Torsional strength (refer to section 5.5)

'Torsional' strength refers to the ability of an item – in this case a chassis – to resist 'twisting' down its length. Torsional strength is very different to bending strength.

It cannot be assumed that any combination of bodies and chassis will provide adequate torsional strength, and each component has to be considered in conjunction with the other. For example, the combination of an unmodified Holden utility chassis fitted with an early American pick-up cab will have significant torsional twist. This is because the Holden cabs were designed to provide part of the vehicle's overall structure, whereas the American manufacturers tended to build a stronger chassis and the body was expected to provide a comparatively minor role in achieving overall torsional strength.

This situation quickly becomes evident with a simple jacking test where the door gaps on the cab will open up significantly. In these cases, additional chassis cross-members will be required.

Torsional testing

There are some situations where it is necessary to assess the torsional strength of a vehicle or a chassis, such as in the case of a stretched limousine, a custom space-frame chassis, or a particularly unusual or innovative design or method of construction.

There are a number of methods available to assess the torsional stiffness of a vehicle or a chassis. These methods include a simple diagonal jacking test (using door openings and gaps to visually determine the level of twist), the more repeatable LVVTA-developed laser-pointer test commonly used for stretched limousines, and the Australian Government's torsional test requirements which are more commonly used for complex or unusual chassis designs or vehicle modifications.

To determine which type of test is the most suitable, constructors are encouraged to discuss this with an LVV Certifier, or to contact a technical staff member at the LVVTA Office.

Ladder chassis material specifications (refer to section 5.8)

Conventional hot rod style hobby cars have typically used 75 mm x 40 mm x 3.0 (3" x 1 ¾" x 1/8") as a minimum frame spec for lighter vehicles such as T-buckets and light roadsters. This spec is marginal, and time has proven that these frames will bow outward at the point where the engine is positioned in the chassis if there isn't an under-slung cross-member at that point linking the two rails.

The following size materials should be followed as a minimum guide for RHS and c-section:

- for light vehicles under 1200 kg (2642 lb), the main rails should be manufactured from no less than 75 mm x 50 mm x 3.0 mm (3" x 2" x 1/8"), with cross-members (irrespective of width and height specs) maintaining 3.0 mm wall thickness; and

- for heavier vehicles over 1200 kg (2642 lb), the main rails should be manufactured from no less than 100 mm x 50 mm x 3.0 mm (4" x 2" x 1/8"), with cross-members (irrespective of width and height specs) maintaining 3.0 mm (1/8") wall thickness.

Space-frame chassis design principles (refer to section 5.13)

Space-frame chassis are built to give the advantage of lightness and rigidity. They comprise predominantly straight small-diameter tube sections, arranged in a fully triangulated truss-like design, some tube sections acting in compression, with others acting in tension. The rigidity of the space-frame chassis relies on the configuration and the spacing of the tube sections acting in unison to contribute to the overall strength.

The strength and rigidity of the overall space-frame chassis structure is dependent on the accuracy of the tube joints and the welding that has been carried out. The failure of one welded or brazed joint can seriously affect the strength of a space-frame chassis.

Because the material typically used in the construction of a space-frame is so small and light, special attention has to be paid to the attachment of components that can transmit high loads back to the chassis, such as suspension, steering, and braking components. Gussets are usually required to assist in spreading the loads being transmitted throughout the greatest possible area of chassis, rather than having the load concentrated on one small area.

Whilst the technical requirements don't specify a limit for the amount of torsional rigidity for a space-frame chassis, it is essential that any flexing that may occur will not lead to cracking of the frame, brackets, or welds, and will not adversely affect front and rear steering geometry.

Space-frame chassis material specifications (refer to section 5.14)

For chassis design similar in size and weight to a Lotus 7, where most tubular boxes can be triangulated, the following size materials should be followed as a minimum guide:

- for vehicles with under 200 horsepower, the main tubes should be manufactured from no less than 25 mm x 1.6 mm (1" x 1/16"), with diagonal bracing manufactured from no less than 19 mm x 1.6 mm (3/4" x 1/16"); and

- for vehicles with over 200 horsepower, the main tubes should be manufactured from no less than 32 mm x 1.6 mm (1 17/64" x 1/16"), with diagonal bracing manufactured from no less than 25 mm x 1.6 mm (1" x 1/16").

Electric Resistance Welded (ERW) tube is considered to be an acceptable material for space-frame chassis construction.

A space-frame type chassis being submitted to the Technical Advisory Committee of the LVVTA for the Build Approval process will require more detailed drawings than a ladder chassis. In the case of a recognised design following closely that of previously manufactured and approved cars such as Lotus 7, Locost, PBR's, space-framed replica Ford GT40's and such, reference to the previous designs should be accompanied by any alterations that are proposed from the original.

Detailed drawings of the original are not usually required, but the TAC may request these.

Space-frame chassis corrosion protection

Space-frame chassis are treated with particular care in the area of corrosion protection, because:

- the pre-body inspection is necessary because parts of a space-frame chassis are often not visible when the outer body panels are fitted, and this is the only time that the corrosion protection issue can be properly assessed; and

- the frame material is usually so thin that corrosion can have a greater effect and in a shorter time than other vehicle types, and unlike purpose-built race-cars which use space-frame chassis, a road-going space-frame chassis is not usually subjected to the same routine strip down and check that a race-car typically receives.

Composite chassis (refer to section 5.18)

The construction of a chassis from composite materials such as fibreglass, Kevlar, carbon-fibre, or aluminium sandwich panel, is a very specialised area, which should not be undertaken by anyone unless the builder has a professional background in working with these materials in structural and load-bearing applications.

Welding high-strength steel (refer to paragraph 5.1.3)

Welding high-tensile or high-strength steels having a strength of less than 440 MpA is generally safe, provided that either MIG or TIG welding is carried out.

Any steels having a strength of more than 440 MpA may not be readily weldable, and should not be welded unless an appropriate welding process is readily available or has been developed and agreed by LVVTA.

Bodies

It is recommended that vehicles fitted with a separate body should have packers or packer strips made from rubber or another type of flexible material to isolate the passenger compartment from chassis vibration and mechanical harmonics.

Frontal Impact performance of production vehicles (refer to section 5.6)

As a result of increased power and torque, a vehicle may need its chassis stiffened in order to improve its torsional performance to maintain or improve handling and body durability. The challenge is to do this without increasing the impact loadings applied to occupants during a collision.

Chassis modifications should ideally achieve the improved torsional stiffness of the vehicle without decreasing the original 'crushability' of the forward part of the vehicle structure.

Any frontal structure modifications made to vehicles manufactured to meet a frontal impact standard may affect the vehicle's ability to progressively deform and thereby absorb frontal crash energy. Also, air-bag deployment could be affected by any stiffening or softening of the vehicle's frontal structure.

It is important, therefore, to obtain expert advice before proceeding with structural modifications to 1990-on vehicles.

Generally speaking, the only way such modifications can be legally made (for road-going competition vehicles) is through the use of a valid LVV Authority Card which specifies Frontal Impact Protection. This process may require a complete alternative occupant protection system, which may include removal of airbags and substitution of occupant restraint systems.

However, this Authority Card only applies to legitimate competition vehicles used by an owner who holds a competition license and is a regular motor-sport competitor.

Frontal Impact-compliant chassis used in scratch-built LVVs

The frontal impact issue also has to be considered when using a production vehicle chassis on a scratch-built vehicle. In theory, if you were to use a chassis from a frontal impact-compliant vehicle in your scratch-built hot rod/sports car, you would have to build the car in such a way as to not mess up the frontal impact characteristics of the chassis.

The reality is however, that it is very unlikely that you'll need to worry about this. Almost all frontal impact-compliant vehicles are of unitary-construction design, so they'll be of no help to your project. About the only frontal impact-compliant vehicles out there that are of separate body/chassis design are ones that are unlikely to find their way under your project because they're either high-end sports cars like Corvettes, or from large 4WD vehicles. Even the 4WD vehicles are mostly going towards unitary construction.

Frontal Impact performance of old-style chassis (refer to section 5.12)

Both original and reproduction chassis on early style cars, will, by their inherent design, naturally provide a considerable degree of frontal impact protection. Energy absorbing deformation will occur to some extent during a frontal impact, because of the taper in the front rails forward of the front cross-member, and also from the way in which the front section of the chassis rails 'droop' downwards. Both of these features will cause some deformation and subsequential energy-absorption within the front of the chassis.

A front-tie-bar between the rails at the forward-most point of the chassis will also assist to absorb crash energy if impacted, by pulling the front of the two front rail sections together and inward.

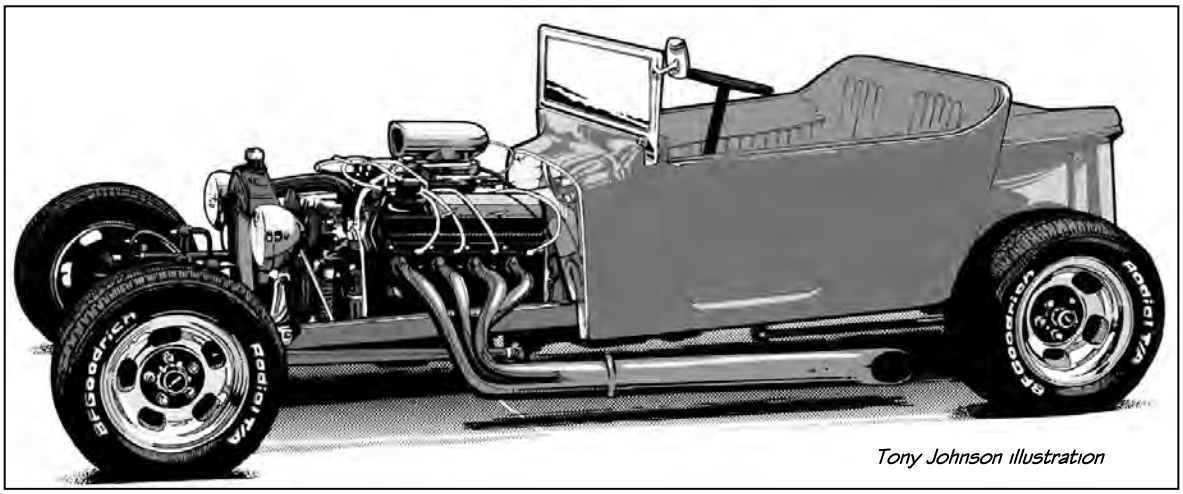
Terms & definitions for Chapter 5 Chassis Modification & Construction

Aftermarket	means a component or system made by a manufacturer, other than a high-volume motor vehicle manufacturer, who produces components or systems on a production-run basis for the mass-market.
Aramid ply	is the generic name for what we know as 'Kevlar'.
Beam-type axle	means a type of axle where wheels are connected laterally by a solid beam or shaft, usually incorporating a kingpin-type swivel at either end on a steering axle.
Capping plate	means a plate fitted to enclose an opening or void in a chassis section.
Carbon	means a non-metallic chemical element, and used in the manufacturing process of steel, gives the steel high strength characteristics.
Chamfered	means the application of a radius, to give a smooth rounded shape to an edge or a corner.
C-notch	means a chassis modification where a 'C' is notched out of the rear chassis rails to increase axle housing clearance during suspension compression, usually carried out in conjunction with significant suspension lowering.
Composite	means a combination of multiple elements used to create a material with different properties.

Cross-member	means a section or beam used to join two parallel sections of chassis, sometimes incorporating a load-bearing mount for engine, drive-line, and suspension components.
Cruciform chassis	means a variation on the ladder frame chassis design, where the central section is reinforced by crossed beams placed perpendicular to each other. This overcomes the inherent lack in torsional stiffness of the basic ladder frame design.
Crush-tube	means a section of non-compressible material that is positioned within a cavity, through which a fastener passes, to prevent collapsing of the material surrounding the cavity, and consequential loosening of the fastener.
Custom	means a service provided, or a component or system manufactured, by an individual person or a company who is not a high-volume motor vehicle manufacturer or aftermarket manufacturer.
Delamination	means the separation of two or more bonded materials, usually through weathering or damage.
Dual-plane	means a type of tubular cross-member design used in chassis construction, where two tubular members sit on top of each other (on two planes).
Drive-shaft safety-loop	means a safety device intended to contain the potentially high rotational forces of a disengaged drive-shaft.
ERW	is an abbreviation for electric resistance welded, which is a common type of steel tubing material.
Fish-plate	means a plate that is positioned on one side of the chassis rail to reinforce the point at which two or more chassis sections join. A fish-plate can be positioned on either the outside or the inside of the chassis rail.
Flange	means a flat surface where two components can be joined, or in the case of a C-section chassis, the top and bottom horizontal surfaces of the chassis rail.
'g'	is an abbreviation for g-force, which is a unit of force equal to the force exerted by gravity, used to indicate the force to which a body is subjected, when accelerated or decelerated.
Gusset	means a rib or triangulation attached or incorporated into a component to increase its strength or torsional rigidity.
Gross Vehicle Mass	means the maximum legal weight at which a vehicle can be operated, including the vehicle's tare, and its payload.
GVM	is an abbreviation for gross vehicle mass.
Kevlar	is a brand name for a particularly light but very strong aramid-fibre, manufactured by the DuPont Company.
Ladder chassis	means a chassis in which parallel side members are joined at intervals by transverse beams, giving the appearance of a ladder.
Longitudinal	means lengthwise (front to back) rather than from left-side to right-side.

Low volume vehicle	means, in simplest terms, a vehicle that is built or modified in small numbers, and includes individual home-built or modified vehicles. See the full low volume vehicle definition contained in the Low Volume Vehicle Code.
MegaPascal	is a unit of pressure.
MpA	is an abbreviation for MegaPascal.
Modified production (low volume vehicle)	means, in simplest terms, a vehicle which, while modified, maintains a sufficient percentage of body or chassis from one primary mass-produced vehicle, that it can still be considered to be that vehicle. See the full modified production (low volume vehicle) definition contained in the Low Volume Vehicle Code.
Modulus	is a physics term for a constant factor or ratio.
Monocoque	means the same as unitary construction.
Osmosis	means the diffusion of fluids through a semi-permeable membrane or porous partition, often found in the automotive world as moisture absorbed and trapped in fibre-glass, resulting in blistering or bubbling of the outer surface.
Perimeter chassis	means a type of chassis frame, commonly used in the construction of 1950s American cars, where the middle sections are outboard of the front and rear chassis rails, to allow for a lower floor-pan in the passenger compartment.
Pull-test	means a test where a pulling force is applied to a component to assess its strength.
RHS	is an abbreviation of rectangular hollow section.
Rectangular hollow section	means a configuration of steel section commonly used in the manufacture of chassis, and other motor vehicle component fabrication.
Scratch-built	is as defined in the Low Volume Vehicle Code.
Space-frame chassis	means a chassis that is built to give the advantage of lightness and rigidity, by using predominantly straight small-diameter tube sections, arranged in a fully triangulated truss-like design, with some tube sections acting in compression and others acting in tension.
Transversely-mounted	means mounted across the vehicle (in an east-west configuration), rather than along its length (in a north-south configuration).
Torsional	means, in the context of this manual, the rotational twisting loads applied throughout the length of a chassis during vehicle operation.
Ultra-high modulus carbon	means, in relation to carbon-fibre, carbon fibres which are extremely stiff, however with less tensile strength than normal carbon.
Unitary-construction	means a type of vehicle construction that incorporates the vehicle body and chassis frame in one unit, as opposed to having a separate and removable chassis.

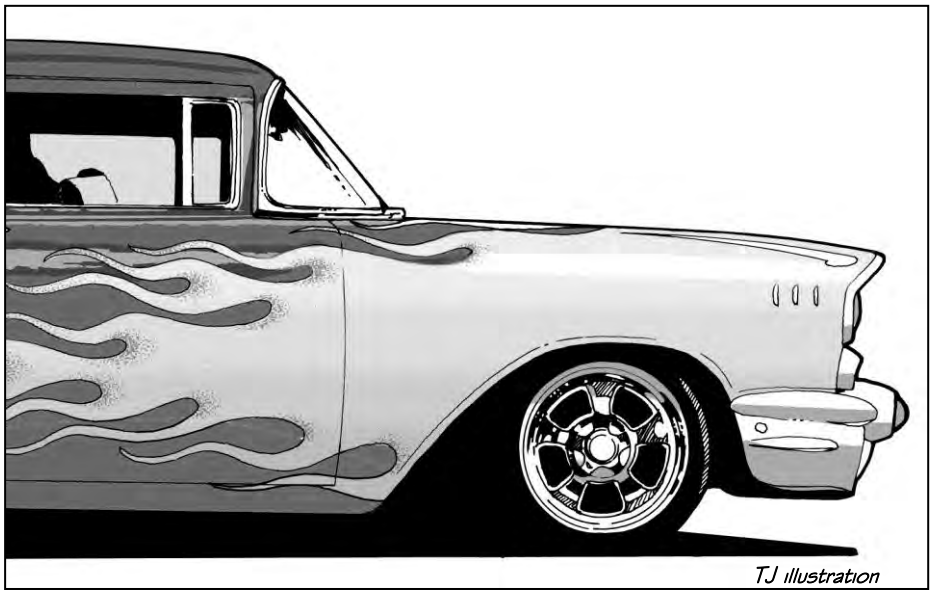
Web means the middle or vertical surface of a C-section chassis rail.



Tony Johnson illustration

Chapter 6:

SUSPENSION SYSTEMS



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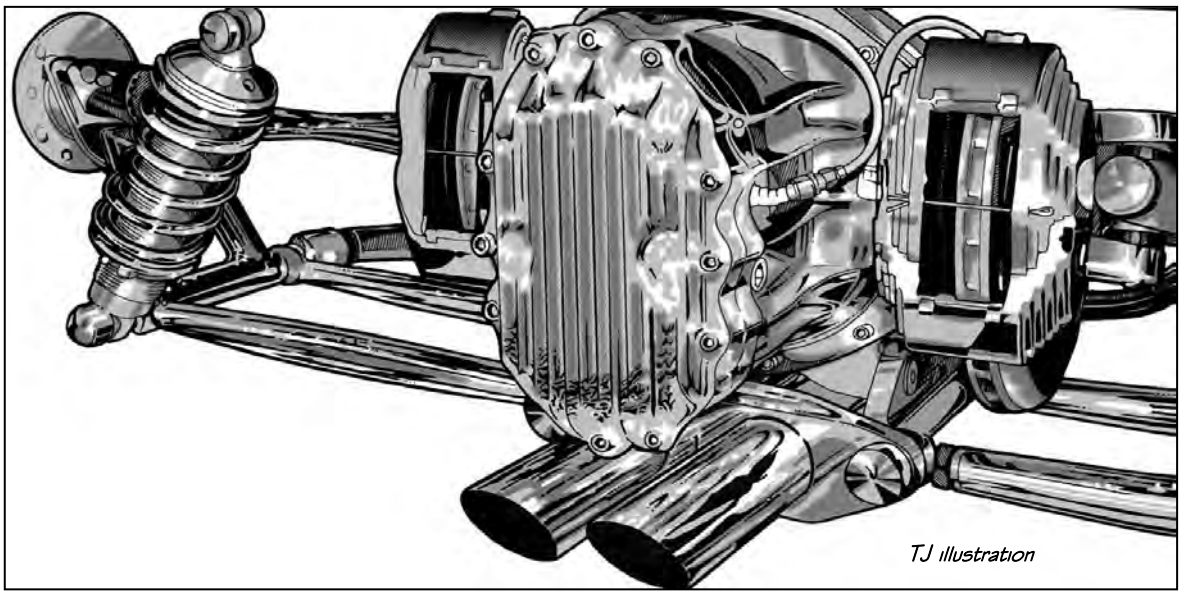
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Key: (for full key details, refer to 'Chapter 2 – About this Manual')

Normal type: Provisions of the NZ Car Construction Manual for all vehicles
Normal type in shaded box: Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates
Italic type: *Extracts from any relevant LVVTA Low Volume Vehicle Standards*
Script type: Helpful hints, tips, explanations, clarifications, and interpretations
Shaded text & dotted vertical stroke in margin: Latest amendments since previous version



CHAPTER 6: SUSPENSION SYSTEMS

Introduction:

In any motor vehicle, the suspension plays a dual role; it isolates the body and chassis from harsh shock loads transmitted from the road surfaces, and maintains the contact patch of each tyre to the road surface. Correct suspension design, construction, and geometry is critical in a hobby vehicle, from the point of view of safety, and also to achieve a vehicle that is ultimately a pleasure to drive. After correcting bad suspension geometry or design as a result of the LVV certification process over the last two decades, literally hundreds, if not thousands of vehicles have been transformed in the way they drive and ride, and as a result the owners' fun-factor has increased hugely.

This section covers the many typical suspension system types commonly used, and provides tried and true good engineering formulas that history and experience have taught us will work reliably and safely. Note that where a production vehicle is fitted with its original unmodified suspension system, the requirements in this chapter do not apply.

Production independent front suspension modification & installation requirements

6.1 Production independent front suspension suitability

6.1.1

A production vehicle independent front suspension unit fitted to a low volume vehicle must be sourced from a donor vehicle of a similar or greater front axle weight to that of the vehicle being modified or constructed.

6.1

'Production' means manufactured by a high-volume motor vehicle manufacturer.

6.2 Production independent front suspension design

6.2.1

Custom control arms fitted to a production vehicle independent front suspension assembly in a low volume vehicle must be individually approved in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc), through the build approval process in 'Chapter 4 - Build Approval Process' to confirm that the control arms incorporate design principles, material specifications, and construction methods that are suitable for their application, prior to commencement of construction.

6.2.1

'Custom' means manufactured by someone other than a reputable aftermarket manufacturer or high-volume motor vehicle manufacturer.

See 'Chapter 4 - Build Approval Process'.

Also look for more information on custom suspensions within LVVTA (Inc)'s Information Sheets, available on www.lvvta.org.nz.

6.3 Production independent front suspension modifications

6.3.1

A custom control arm fitted to a production vehicle independent front suspension assembly in a low volume vehicle, must:

(a) meet the material requirements specified in Table 6.1; and

(b) be constructed in such a way that any threaded section provided for adjustability is incorporated directly into the control arm material; and

(c) in the case of welded joints, have the material sections joined in such a way as to provide the greatest weld area practicable; and

(d) in the case of an arm which supports the corner-weight of the vehicle, incorporate at the outer end, either:

(i) a purpose-designed automotive ball-joint from a production vehicle of a similar or greater corner weight; or

(ii) a custom bush assembly that is purpose-designed for supporting at least the corner-weight of the vehicle to which the suspension is fitted.

6.3.1(a) & (b)

For example, use, say, schedule 80 15mm (19/32") nominal bore tube drilled & tapped directly for a 16 mm (5/8") rod end – this keeps the material spec beefy (which it needs to be) and avoids the need to weld threaded 'spuds' into the arms to accept the rod-end.

6.3.1

A 'custom bush assembly' includes spherical bushes.

6.3.2

Welding within the modification process of an original independent front suspension cross-member within a low volume vehicle must be carried out in accordance with the welding requirements for non-critical components specified in 18.7 and 18.8 of 'Chapter 18 - Attachment Systems'.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.3.2, provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

6.3.3

Welding within the modification process of a production vehicle independent front suspension component in a low volume vehicle, other than the main cross-member, must be carried out:

(a) only on components manufactured from a low to medium tensile strength mild steel; and

(b) in accordance with the welding requirements for critical components specified in 18.9 of 'Chapter 18 - Attachment Systems'.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.3.3(b), provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

6.3.4

Welding within the manufacturing process of a custom component which replaces an original component within a production vehicle independent front suspension in a low volume vehicle, must be carried out:

(a) only on components manufactured from readily weldable steels, such as low to medium tensile strength mild steel, weldable stainless steel, or chrome-moly; and

(b) in accordance with the welding requirements for critical components specified in 18.9 of 'Chapter 18 - Attachment Systems'.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.3.4(b), provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

6.3.5

A suspension component within a production vehicle independent front suspension in a low volume vehicle that is manufactured using a casting or forging process, must not, in any circumstances, be either:

(a) heated; or

(b) bent; or

(c) welded.

6.3.6

A custom suspension joint, such as an adjustable rod end, may be fitted to a production independent front suspension in a low volume vehicle to replace an original suspension joint, in order to achieve an increased range of adjustability and improved suspension geometry, provided that the joint:

6.3.4(a)

A typical weldable stainless steel is a 304L or 316L grade. The 'L' denotes low carbon, which means it can be successfully welded.

6.3.5

No heating, bending, or welding of a casting or a forging is a basic low volume vehicle system principle that should never be broken, except in special circumstances that are specified and controlled within this manual.

6.3.6

Custom suspension joints include rubber or urethane-bushed aftermarket rod ends, and spherical bearing rod ends.

See sections 6.41 to 6.46 for the technical requirements for custom suspension joints.

(a) meets the applicable requirements specified for the suspension joints in 6.42 or 6.43; and

(b) is only loaded in compression or tension through its longitudinal axis.

6.3.6 (b)

This means that a rod end can't be used as a bottom ball joint, because rod ends are not designed for constant side-load, and they wear faster than a proper automotive load-carrying ball-joint will.

6.4 Production independent front suspension installations

6.4.1

An installation of a production vehicle independent front suspension cross-member in a low volume vehicle that involves welding must be carried out in accordance with the welding requirements for non-critical components specified in 18.7 and 18.8 of 'Chapter 18 - Attachment Systems'.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.4.1, provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

6.4.2

An installation of a production vehicle independent front suspension beam in a low volume vehicle that is attached by bolting onto the chassis, must incorporate no less number and size fasteners than that used in the suspension beam's original location.

6.4.3

A production vehicle independent front suspension fitted with brake reaction rods that are installed in a low volume vehicle, must incorporate sufficiently reinforced or gusseted attachment points to ensure that the brake reaction rods are supported no less rigidly than in their original location.

6.4.3

Brake reaction rods are also known as strut rods or lower arm rods, and can be subjected to very high loads.

6.4.4

A production vehicle independent front suspension fitted with torsion bar springing that is installed in a low volume vehicle, must be attached in such a way that enables the loads transmitted by the torsion bars to be supported by a sufficiently reinforced part of the chassis.

6.4.5

A production vehicle independent front suspension must be installed in a low volume vehicle in such a way as to enable the correct caster angle, as specified in 7.34 in 'Chapter 7 - Steering Systems', to be achieved during final alignment.

6.4.5

This needs to be carefully set-up taking into account tyre sizes and final front to rear vehicle rake before installation, especially if the beam is being welded into the chassis.

See notes on caster in the 'Useful Information' section at the end of this chapter.

Custom independent front suspension requirements

6.5 Custom independent front suspension design

6.5.1

A custom-built independent front suspension assembly fitted to a low volume vehicle must be individually approved in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc), through the build approval process specified in 'Chapter 4 - Build Approval Process', to confirm that the suspension assembly incorporates design principles, material specifications, and construction methods that are suitable for their application, prior to commencement of construction.

A custom-built independent front suspension assembly built before 1992 is not required to comply with 6.5.1.

6.5.2

A custom-built independent front suspension assembly fitted to a low volume vehicle must incorporate control arms manufactured from a material specification not less than that specified in Table 6.1.

A custom-built independent front suspension assembly built before 1992 is not required to comply with 6.5.2, provided that after thorough inspection, no bending, fatigue cracking, or fracturing is evident on the arms. Specific investigation for fatigue cracking must be carried out, with removal of paint if necessary to assist the inspection process.

6.5.1

'Custom' means manufactured by someone other than a reputable aftermarket manufacturer or high-volume motor vehicle manufacturer.

See 'Chapter 4 - Build Approval Process'.

Also look for more information on custom suspensions within LVVTA (Inc)'s Information Sheets, available on www.lvvta.org.nz.

6.5.2

Table 6.1 assumes that the upper arm is unloaded and the lower arm is loaded. Where this does not occur (eg rocker arm, or spring is mounted to top arm) the TAC should be consulted.

The lower arm must never be reduced below that specified in the table, irrespective of whether or not the lower arm is loaded.

See additional A-arm material notes next page.

VEHICLE TYPE	WEIGHT	A-ARM MATERIAL	
		Upper arms	Lower arms
▪ Lotus 7 replica ▪ Light-weight space-frame sports special	500 kg (1100 lb)	22 mm (7/8") OD x 1.6 mm (1/16") wall thickness, ERW or seamless tube	25 mm (1") OD x 2.0 mm (5/64") wall thickness, ERW or seamless tube
▪ Heavy-weight space-frame sports special ▪ Medium-weight ladder-chassis sports car (MGTF replica) ▪ Light-weight hot rod (T-bucket, fenderless roadster) ▪ Small unit-construction sedan (Civic, Mazda 323)		15 mm (19/32") NB schedule 40 (22 mm [7/8"] OD x 3.3 mm [9/64"])	20 mm (51/64") NB schedule 40 (25 mm [1"] OD x 3.2 mm [1/8"])
▪ Heavy-weight ladder-chassis sports car (Cobra) ▪ Medium-weight hot rod (coupe, pick-up) ▪ Large unit-construction sedan (Camaro, Commodore)		15 mm (19/32") NB schedule 80 (22 mm [7/8"] OD x 4.0 mm [5/32"])	20 mm (51/64") NB schedule 80 (25 mm [1"] OD x 4.0 mm [5/32"])

▪ Heavy-weight hot rod (30s & 40s sedan)	2200 kg (4840 lb)	20 mm (51/64") NB schedule 80 (25 mm [1"] OD x 4.0 mm [4/32"])	20 mm (51/64") NB schedule 80 (25 mm [1"] OD x 4.0 mm [5/32"])
▪ Full size body/chassis car (50s & 60s sedan)		20 mm (51/64") NB schedule 80 (25 mm [1"] OD x 4.0 mm [4/32"])	25 mm (1") NB schedule 80 (33 mm [1 5/16"] OD x 5.0 mm [3/16"])

Table 6.1 Custom IFS A-arm material guide table

6.6 Custom independent front suspension construction

6.6.1

A custom-built independent front suspension assembly fitted to a low volume vehicle, must:

(a) be constructed in such a way that any threaded section that is provided for adjustability is incorporated directly into the control arm material; and

(b) in the case of welded joints, have the material sections joined in such a way as to provide the greatest weld area practicable; and

(c) incorporate at the outer end, except in the case where the suspension arm is not a loaded arm, either:

(i) a purpose-designed automotive ball-joint from a production vehicle of a similar corner weight; or

(ii) a custom bush assembly that is purpose-designed for carrying the corner weight of the vehicle to which the suspension is fitted.

6.6.2

Welding within the construction process of a front suspension cross-member within a custom independent front suspension in a low volume vehicle, must be carried out in accordance with the welding requirements for non-critical components specified in 18.7 and 18.8 of 'Chapter 18 - Attachment Systems'.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.6.2, provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

6.6.3

Welding within the construction process of a custom component within a custom independent front suspension assembly in a low volume vehicle, must be carried out:

6.5.2 (cont'd)

Note that oval-section thin-wall tubing may be used in the construction of IFS A-arms, however in such circumstances the TAC should be consulted.

The ideal approach for material selection for custom built control arms is to use, say, schedule 80 15mm (19/32") nominal bore tube drilled & tapped directly for a 16 mm (5/8") rod end – this keeps the material spec beefy (which it needs to be) and avoids the need to weld threaded 'spuds' into the arms to accept the rod-end.

See 'Custom IFS A-arm material specifications' under the Useful Information section at the back of this chapter for some exceptions to these arm size rules.

6.6.1(c)(i)

See 'loaded suspension joints' in the 'Useful Information' section.

(a) only on components manufactured from readily weldable steels, such as a low to medium tensile strength mild steel, weldable stainless steel, or chrome-moly; and

(b) in accordance with the welding requirements for critical components specified in 18.9 of 'Chapter 18 - Attachment Systems'.

6.6.3(a)

A typical weldable stainless steel is a 304 L or 316 L grade. The 'L' denotes low carbon, which means it can be successfully welded.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.6.3(b), provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

6.6.4

A suspension component within a custom independent front suspension in a low volume vehicle that is manufactured using a casting or forging process, must not, in any circumstances, be:

(a) heated; or

(b) bent; or

(c) welded.

6.6.4

No heating, bending, or welding of a casting or a forging is a basic engineering principle that should never be broken, except for in special circumstances that are specified and controlled within this manual.

6.6.5

A custom suspension joint, such as a custom bushed rod end, may be fitted within a custom independent front suspension in a low volume vehicle, provided that the joint:

(a) meets the applicable requirements specified for suspension joints in 6.42 or 6.43; and

(b) is only loaded in compression or tension through its longitudinal axis.

6.6.5

Custom suspension joints include rubber or urethane-bushed aftermarket rod ends, and spherical bearing rod ends.

'I-beam' refers to the beam axles used prevalently by high volume vehicle manufacturers (particularly Ford) from the turn of the century to the late 1940s, and beyond for commercial vehicles.

Beam axle front suspension requirements

6.7 I-beam axle front suspension systems

6.7.1

An I-beam axle in a low volume vehicle must be sourced from either:

(a) a production vehicle of a comparable or greater weight than the vehicle being modified or constructed; or

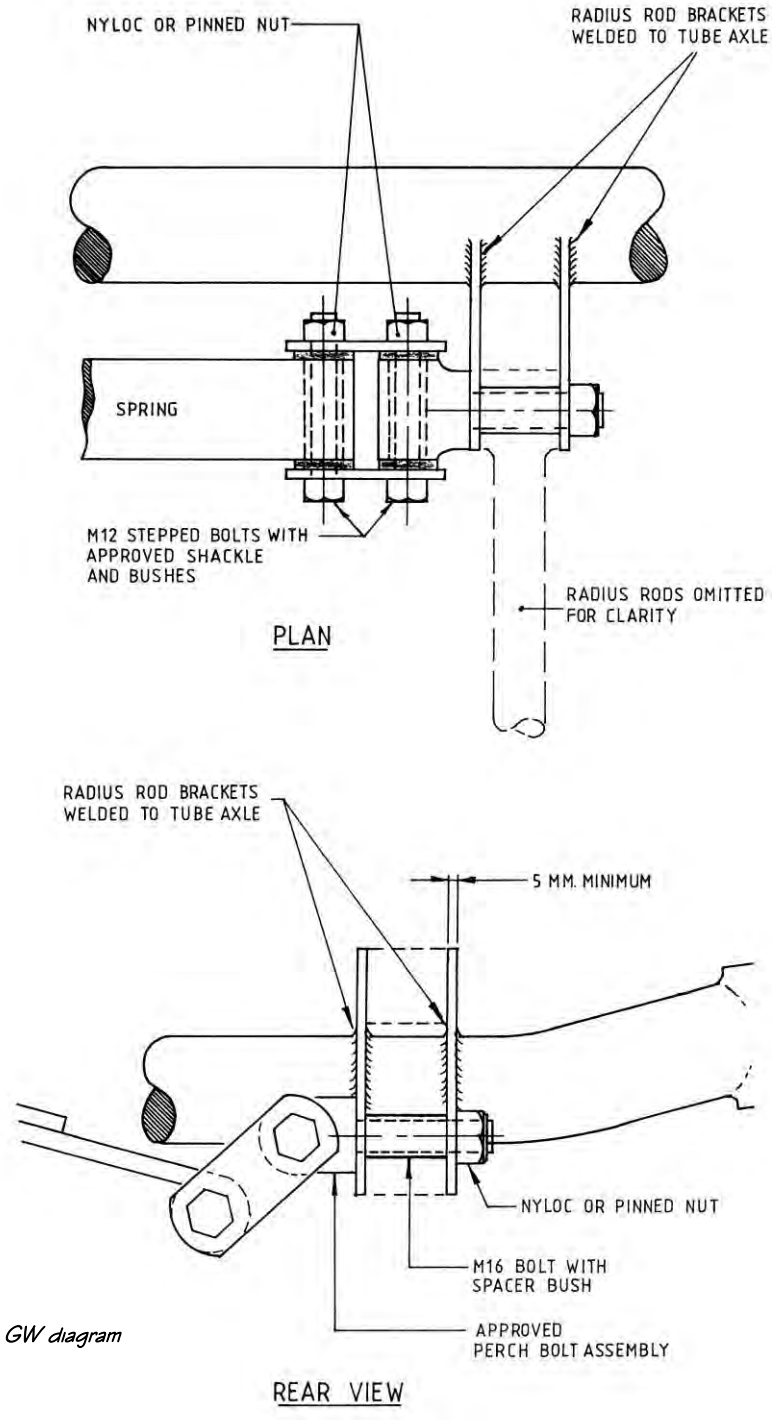
(b) a reputable aftermarket company that has a long history in manufacturing quality suspension components.

6.7.1

After-market I-beam axles such as those made by Magnum, Superbell, and Chassis Engineering are all considered to be good quality components.

6.7.2

An I-beam axle in a low volume vehicle that incorporates coil springs to support the vehicle weight must not have the springs mounted on attachment points that were originally designed and manufactured for mounting just shock absorbers.



GW diagram

Diagram 6.1 Approved spring shackle assembly design

6.7.2

This means 'Pete & Jake' style shock mounts can't be used to support the vehicle weight through mounting coil-over shocks onto them – these are designed for shock absorbers on their own, and rely on a leaf spring to take the vehicle weight.

6.7.3

An I-beam axle in a low volume vehicle that is attached to a leaf spring must incorporate a spring shackle assembly that:

(a) follows the approved design principles shown in Diagram 6.1; and

(b) in order to prevent binding of the spring shackle assembly when fully tightened, incorporates either:

(i) the correct stepped-shoulder bolt; or

(ii) a steel inner sleeve.

6.7.3

See Diagram 6.1 for approved spring shackle assembly design.

6.8 I-beam axle front suspension modifications

6.8.1

An I-beam axle that is manufactured using a forging process, and has been drilled across the web section of the beam, may be fitted to a low volume vehicle that has a tare of not more than 1500 kgs (3300 lbs), provided that:

(a) the holes are drilled centrally within the web section of the beam; and

(b) the hole size does not exceed 20 mm (51/64″); and

(c) not less than 5 mm (3/16″) of beam material remains above and below the holes within the vertical web section of the beam; and

(d) not less than 20 mm (51/64″) of beam material remains between the holes; and

(e) the outboard holes are positioned no closer to the perch-bolt housing than 80 mm (3 5/32″); and

(f) the vehicle's front tyre size is kept close to the minimum allowable size.

6.8.1

'Tare' is the unladen weight of the vehicle.

The TAC believes that, at the time of print, other than OE I-beam axles, only Chassis Engineering (USA) are forged, whereas other aftermarket units are manufactured using a casting process.

Note that aftermarket I-beam axles manufactured by reputable companies like Magnum, Superbell, and Chassis Engineering can have holes larger than those specified here, provided that the axles are in unmodified as-manufactured condition.

A low volume vehicle may be built or modified using a drilled cast axle before 2007, but no drilled axles manufactured using a casting process may be fitted to a low volume vehicle after that date.

6.8.2

A pre-1950s era production vehicle I-beam axle that is manufactured using a forging process, and has been heated and bent to 'drop' the axle, may be fitted to a low volume vehicle that has a tare weight of not more than 1500 kg (3300 lb), provided that:

6.8.2

'Dropping' an I-beam axle means the 'dropping' or 'stretching' process applied to an I-beam axle to lower the vehicle's ride height.

(a) the I-beam has not been electroplated prior to the heating and bending process; and

(b) the I-beam is a low-tensile strength forged steel; and

(c) the correct temperature has been applied during the heating process so as not to alter the steel's molecular structure or strength; and

(d) the correct equipment has been used to apply the change in shape; and

(e) the process is carried out only by a specialist within the field specifically nominated by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc); and

(f) a consistent and flowing shape has been maintained in the affected area; and

(g) the area of the I-beam axle where the heating and bending has occurred is non-destructively tested, using either the ultra-sonic, x-ray, or magnetic particle method, by a person specified by the specialist who carries out the dropping process.

6.8.2(c)

This requires a thorough visual inspection with the material in its raw and cleaned state, to ensure that 'over-cooking' has not occurred.

6.8.2(f)

This refers particularly to 'necking' (thinning out) of the beam section that occurs if the stretching process is applied without the correct amount of heat being applied.

6.8.2(g)

The NDT methods specified here will identify any surface cracking or fracturing as a result of the heating and bending process.

6.8.3

An I-beam axle in a low volume vehicle that is manufactured using a casting or forging process must not be welded in any circumstances, except for that specified in 6.8.4.

6.8.4

An I-beam axle in a low volume vehicle that is manufactured using a forging process, may be converted into a swing axle suspension system, incorporating a pivot eye welded to each section of the axle beam, provided that:

6.8.4

A swing-axle suspension system is a modification that was popular amongst predominantly smaller pre-1960s sports vehicles modified for use in hill climbs and other motor-sport activities.

(a) the I-beam has not been electroplated prior to the welding process; and

(b) the I-beam is a low-tensile strength forged steel; and

(c) a mild steel pivot eye is welded over the maximum available weld area to each beam section; and

(d) the welding is confined to within the third of each axle section closest to the vehicle longitudinal centre-line; and

(e) no binding or twisting occurs within either axle section whilst they travel throughout their arcs when connected to the radius rods; and

(f) the welded pivot eye incorporates a flexible bushing material and pivots freely; and

(g) the welded pivot eye is positioned and attached to the vehicle structure in such a way so as not to be supporting the weight of the vehicle; and

(h) the welding is carried out in accordance with the welding requirements for critical components specified in 18.9 'Chapter 18 - Attachment systems'.

6.8.4(g)

This means the spring and shock absorber must be positioned as far toward the outside of the vehicle as possible, in order to reduce the amount of vehicle weight being supported by the pivot eyes.

6.9 Tubular beam axle front suspension systems

6.9.1

A tubular beam axle in a low volume vehicle that is attached to a leaf spring must incorporate a spring shackle assembly that:

6.9.1

See Diagram 6.1 for approved spring shackle assembly design.

(a) follows the approved design principles shown in Diagram 6.1; and

(b) in order to prevent binding of the spring shackle assembly when fully tightened, incorporates either:

(i) the correct stepped-shoulder bolt; or

(ii) a steel inner sleeve.

6.10 Tubular beam axle front suspension construction and modification

6.10.1

Welding within the modification or construction process of a tubular beam axle front suspension system in a low volume vehicle, must be carried out:

(a) only on components manufactured from readily weldable steels, such as a low to medium tensile strength mild steel, weldable stainless steel, or chrome-moly; and

6.10.1(a)

A typical weldable stainless steel is a 304 L or 316 L grade.

The 'L' denotes low carbon, which means it can be successfully welded.

(b) in accordance with the welding requirements for critical components specified in 18.9 'Chapter 18 - Attachment Systems'.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.10.1(b), provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

6.10.2

A suspension component within a tubular beam axle front suspension system in a low volume vehicle that is manufactured using a casting or forging process must not, in any circumstances, be:

(a) heated; or

(b) bent; or

(c) welded.

6.10.2

No heating, bending, or welding of a casting or a forging is a basic engineering principle that should never be broken, except in special circumstances that are specified and controlled within this manual.

This is detailed further under 'Welding of castings and forgings' in the 'Useful Information' section, at the end of this chapter.

6.11 King-pin attachment & modifications for front suspensions

6.11.1

A king-pin within a tubular or I-beam axle fitted to a low volume vehicle must:

(a) be of a size that is a neat fit within the king-pin housing section of the axle; and

(b) features a positive means of preventing the king-pin from:

(i) rotating within the housing; or

(ii) moving vertically within the housing.

6.11.2

A tubular or I-beam axle must be designed and manufactured in such a way that a cotter-pin can be positioned to positively locate the king-pin in its correct location.

A low volume vehicle that was built or modified before 2007 may use a grub-screw to locate the king-pin in its correct location instead of the cotter pin required by 6.11.2, provided that the grub-screw:

(a) is lock-nutted to prevent unintended loosening of the grub-screw; and

(b) locates against a flat surface machined into the king-pin of sufficient depth to enable secure engagement against; and

(c) is supplemented by a secondary method of securing the king-pin within the king-pin housing.

Shaded box (c)

A frost-plug at the bottom of the king-pin housing is not considered an acceptable secondary method.

6.11.3

A cotter pin, a grub-screw, or other securing device, must not be used as a means of securing a worn king-pin, or king-pin of an incorrect size, from moving within the king-pin housing.

Front suspension stub axle and hub assembly requirements

6.12 Stub axle suitability in front suspensions

6.12.1

A hub assembly in a low volume vehicle must:

(a) be securely attached to the stub axle using a vibration-proof fastening method; and

(b) incorporate a dust cap or other suitable sealing device to protect the axle bearings from foreign matter.

6.12

The term 'stub axle' means the complete stub axle or 'upright' assembly. The 'spindle' is the machined section that the hub bearings run on, otherwise known as the 'pin' or 'axle'. Sometimes the spindle is not part of the stub axle forging, but is a separate pressed-in item, such as those found on early Jaguars.

6.12.1(b)

An LVV Certifier should remove the dust cap to verify that this has taken place.

6.12.2

A production vehicle stub axle assembly fitted to a low volume vehicle must be sourced from a donor vehicle of a similar or greater front axle weight to that of the vehicle being modified or constructed.

6.12.3

A production low volume vehicle that retains its original hub assembly, and is fitted with an engine that is substantially heavier than that which the vehicle's original hub assembly was designed to support, must have either:

(a) an increased number of wheel studs fitted; or

(b) the original wheel studs replaced by studs of a larger diameter.

6.12.4

A stub axle fitted to a low volume vehicle must be supported at mounting points that are vertically loaded, by load-bearing ball-joints, and not other rod end-type suspension joints that are not designed for load-carrying operation.

6.12.4

Typical spherical bearing rod ends are not designed to support vehicle weight – they are designed for compression and tension loadings. This does not apply to typical non-load bearing situations such as the top pivot/camber adjustment plate on a McPherson strut assembly.

6.13 Stub axle modifications in front suspensions

6.13.1

A production vehicle stub axle assembly fitted to a low volume vehicle must not incorporate any:

(a) welding to any cast or forged suspension upright or stub axle, or steering arm; or

(b) reduction of the spindle diameter by machining or any other means; or

(c) alteration to the original radii contained on the spindle.

A stub axle fitted to a low volume vehicle built or modified before 1992 is not required to comply with (b) or (c) of 6.13.1, provided that the original radii has been replicated during the machining process.

6.13.1(b)

The only stub axle spindle machining that may be carried out is to extend an existing bearing surface for bearing adaptation, or to shorten the outer end of a spindle.

Where a brake adaptation has taken place, or where an LVV Certifier suspects a brake adaptation has taken place, the hub assembly will need to be removed to enable a thorough visual inspection of radii.

LVV Certifiers must look very carefully to ensure that disallowed modifications have not occurred to cast or forged stub axles, and where in doubt, they may need to make a visual comparison with a known original unit.

6.14 Custom stub axle design and construction in front suspensions

6.14.1

A custom spindle fitted to a low volume vehicle that is either integral with the stub axle assembly, or separate to the stub axle assembly, must not be manufactured using a casting process.

6.14.2

A custom spindle fitted to a low volume vehicle, that is separate to the stub axle assembly, must:

(a) be manufactured from a high quality low alloy steel; and

(b) incorporate correct machining procedures including maintaining the correct radii at diameter changes; and

(c) be comparable in all critical dimensions to a spindle from a production vehicle of a similar weight as that of the vehicle to which the custom spindle is fitted.

6.14.2

'Custom' means manufactured by someone other than a reputable aftermarket manufacturer or high-volume motor vehicle manufacturer.

6.14.2(a)

A medium grade chrome-moly material such as 4140 is considered a suitable material for spindle manufacture.

6.14.3

A custom-built stub axle assembly may be fitted to a low volume vehicle provided that it has been individually approved in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc), through the build approval process specified in 'Chapter 4 - Build Approval Process', prior to the commencement of construction.

6.14.3

See more information on next page.

Longitudinal (front suspension) location link requirements

6.15 All radius rods in front suspensions

6.15.1

A radius rod used to locate an I-beam or tubular axle in a low volume vehicle must be either:

(a) sourced from a production vehicle of a comparable or greater weight than the vehicle being modified or constructed; or

(b) of a design and material specification that will withstand the suspension and braking reaction loads that the rods are subjected to.

6.15.2

In the case of a radius rod used to locate an I-beam or tubular axle in a low volume vehicle, the rods must be as long as practical, so as to minimise caster angle changes throughout the suspension's range of travel.

6.15.3

A radius rod used to locate an I-beam or tubular axle in a low volume vehicle must be attached at both the axle end and the chassis end with fasteners that:

(a) are of a diameter of not less than 12 mm (1/2"); and

(b) meet the requirements specified for fasteners in 'Chapter 18 - Attachment Systems'.

6.16 Split production radius rods in front suspensions

6.16.1

Production radius rods may be split away from their original single mounting point triangulated configuration and attached to new mounting points on each side of the chassis of a low volume vehicle, provided that:

(a) the vehicle to which the axle and radius rods are fitted has minimal suspension travel; and

(b) the axle to which the radius rods attach is an I-beam axle manufactured using either:

6.14.3

This process is necessary even for units manufactured by lesser known aftermarket manufacturers, as whilst the more reputable aftermarket stub axle manufacturers (such as Bell-tech, Lorider) sell good products, there are other aftermarket units that are poorly designed and unacceptable.

6.15.1

A 'longitudinal' link is a link that locates an axle in the fore-aft direction, such as a radius rod, or 4-bar system.

6.15.2

Approximately 600 mm (23 5/8") or longer is considered a suitable length for a radius rod in most applications.

6.16.1

Original radius rods may be attached to a tube axle if they meet at the center of the vehicle as per original, or even if slightly shortened to overcome clearance problems, provided the rods follow the same angle as original.

(i) a forging process; or

(ii) a casting process provided that the material used in the casting process is a steel or ductile iron.

A low volume vehicle built or modified before 2007, is not required to comply with 6.16.1, provided that no apparent cracking, twisting, or other damage has occurred to the axle, radius rods, or their mounting points.

6.16.1(b)

A commonly-used I-beam axle manufactured using a casting process is the 'Superbell'. This axle uses a highly-malleable steel, which results in properties similar to that of a forged axle. As such, these may be used.

6.16.2

Production radius rods split away from their original single mounting point triangulated configuration must not be attached to new mounting points on each side of the chassis of a low volume vehicle if locating either a:

(a) tubular axle; or

(b) custom I-beam axle that is manufactured using a casting process, and where the material used in the casting process is not steel or ductile iron.

A low volume vehicle built or modified before 2007 is not required to comply with 6.16.2, provided that no apparent cracking, twisting, or other damage has occurred to the axle, radius rods, or their mounting points.

6.16.2

Old Ford I-beam axles will twist to some degree, however a certain amount of caster change will occur as a result of the twisting effect on the axle that takes place during suspension travel. This is why this system should not be used on vehicles with a lot of suspension travel.

The TAC believes that, at the time of print, other than OE I-beam axles, only Chassis Engineering (USA) are forged, whereas other aftermarket units are manufactured using a casting process. Cast axles must never be used in a suspension system that can apply any twisting loads to the axle unless the material used in the casting process is either steel or ductile iron. A forged I-beam axle is always preferred by the TAC over a cast axle, irrespective of material type.

6.16.3

Split production radius rods used to locate an I-beam axle in a low volume vehicle must be attached at the chassis with either:

(a) custom bushed rod ends that meet the requirements specified in 6.42.1; or

(b) custom spherical bearing rod ends that meet the requirements specified in 6.43.1; or

(c) tie-rod ends that meet the requirements specified in 6.44.1.

6.16.4

Split production radius rods used to locate an I-beam axle in a low volume vehicle must be attached at the axle with either:

(a) custom bushed rod ends that meet the requirements specified in 6.42.1; or

(b) custom clevis rod ends that meet the requirements specified in 6.45.

6.16.5

The forward end of a production vehicle radius rod used to locate an axle in a low volume vehicle may be modified by re-welding or heating and bending, providing that:

(a) the process is being applied in order to enable correct caster and spring alignment during the process of splitting the radius rods from their original single mounting point to new mounting points on each side of the chassis;

(b) and either:

(i) in the case of welding, the welding is carried out in accordance with the welding requirements for critical components specified in 18.9 of 'Chapter 18 - Attachment Systems'; or

(ii) in the case of heating and bending, the heating and bending is carried out by a specialist within the field specifically nominated by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc).

Welding carried out on a vehicle built before 1992 is not required to comply with 6.16.5(b), provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

6.17 Production radius rod modification in front suspensions

6.17.1

A production vehicle radius rod that is manufactured using a forging process, and has been drilled through its neutral axis, may be fitted to the front axle of a low volume vehicle that has a tare of not more than 1500 kg (3300 lb), provided that:

(a) the holes are drilled centrally within the radius rod; and

(b) the hole size does not exceed half of the radius rod depth throughout the length of the rod; and

(c) the holes are 'tubed' with a mild steel material of not less than 3 mm (1/8") in wall thickness; and

(d) the welding of the tubing into the radius rods is carried out in accordance with requirements specified in 18.7 of 'Chapter 18 - Attachment Systems'; and

(e) not less than 30 mm (13/16") of radius rod material remains between the holes; and

(f) the outboard holes are positioned no closer to the perch-bolt housing than 80 mm (3 5/32").

6.17.1

Radius rods referred to here are primarily those used by high volume vehicle manufacturers (particularly Ford) from shortly after the turn of the century to the late 1940s.

'Tare' is the unladen weight of the vehicle.

Drilled through the 'neutral axis' means drilled through the sides (on a horizontal plane), rather than from top to bottom.

6.18 Hairpin radius rods in front suspensions

6.18.1

Hairpin radius rods may be attached to mounting points on each side of the chassis of a low volume vehicle, provided that:

(a) the vehicle to which the axle and hairpin radius rods are fitted has minimal suspension travel; and

(b) the hairpin radius rods are as long as can practicably be achieved so as to minimise caster change during suspension travel; and

(c) the axle to which the hairpin radius rods attach is an I-beam axle manufactured using either:

(i) a forging process; or

(ii) a casting process provided that the material used in the casting process is a steel or ductile iron.

A low volume vehicle built or modified before 1992 is not required to comply with 6.18.1, provided that no apparent cracking, twisting, or other damage has occurred to the axle, radius rods, or their mounting points.

6.18.1

Old Ford I-beam axles will twist to some degree, however a certain amount of caster change will occur as a result of the twisting effect on the axle that takes place during suspension travel. This is why this system should not be used on vehicles with a lot of suspension travel.

The subject of caster, and its effects, is covered in detail in the 'Useful Information' section at the end of 'Chapter 7 – Steering Systems'

6.18.2

Hairpin radius rods fitted to a low volume vehicle must not be attached to mounting points on each side of the chassis if locating either a:

(a) tubular axle; or

(b) custom I-beam axle that is manufactured using a casting process, and where the material used in the casting process is not steel or ductile iron.

A low volume vehicle built or modified before 1992 is not required to comply with 6.18.2, provided that no apparent cracking, twisting, or other damage has occurred to the axle, radius rods, or their mounting points.

6.18.3

Hairpin radius rods used to locate an I-beam axle in a low volume vehicle must be attached at the chassis with either:

(a) custom bushed rod ends that meet the requirements specified in 6.42.1; or

(b) custom spherical bearing rod ends that meet the requirements specified in 6.43.1; or

(c) tie-rod ends that meet the requirements specified in 6.44.1.

6.18.4

Hairpin radius rods used to locate an I-beam axle in a low volume vehicle must be attached at the axle with either:

(a) custom bushed rod ends that meet the requirements specified in 6.42.1; or

(b) custom clevis joints that meet the requirements specified in 6.45.1.

6.19 Parallel four-link radius rods in front suspensions

6.19.1

A parallel four-link radius rod system used to locate an I-beam or tubular axle in a low volume vehicle must:

(a) be equal in length; and

(b) maintain the same distance between the front and rear of each pair of four-link radius rods; and

(c) be of a design and material specification, and maintain sufficient distance between each upper and lower pair of four-link radius rods, so as to be able to withstand the suspension and braking reaction loads that the rods are subjected to; and

(d) in the case of a parallel four-link radius rod manufactured from aluminium, be supported by documented evidence to substantiate that the material that the aluminium rods are made from, provides equal or greater strength than a typical mild steel rod.

6.19.1(b)

A typical minimum material specification for a medium weight vehicle is schedule 80 12 mm (½") nominal bore seamless tubing (equivalent to 22 mm [7/8"] 8-gauge).

6.19.1(c)

The minimum practical distance between top and bottom arms for a medium-weight vehicle in order to resist brake reaction loads is 120 mm (4 ¾").

6.19.2

A parallel four-link radius rod used to locate an I-beam or tubular axle in a low volume vehicle must be attached to bat-wing brackets and perch-bolt assemblies by either:

(a) a double-shear attachment method that incorporates:

(i) the approved design principles shown in Diagram 6.2; and

(ii) custom bushed or spherical bearing rod ends that meet the requirements specified in 6.42.1 or 6.43.1;

6.19.2

Double-shear is always a preferred method over single-shear.

or

(b) a single-shear attachment method that incorporates:

(i) mild steel plate of a thickness not less than 8 mm (5/16″); and

(ii) a custom spherical bearing rod end that meets the requirements specified in 6.43.1

6.19.3

A parallel four-link radius rod used to locate an I-beam or tubular axle in a low volume vehicle must be attached at the chassis with either:

(a) custom bushed rod ends that meet the requirements specified in 6.42.1; or

(b) custom spherical bearing rod ends that meet the requirements specified in 6.43.1.

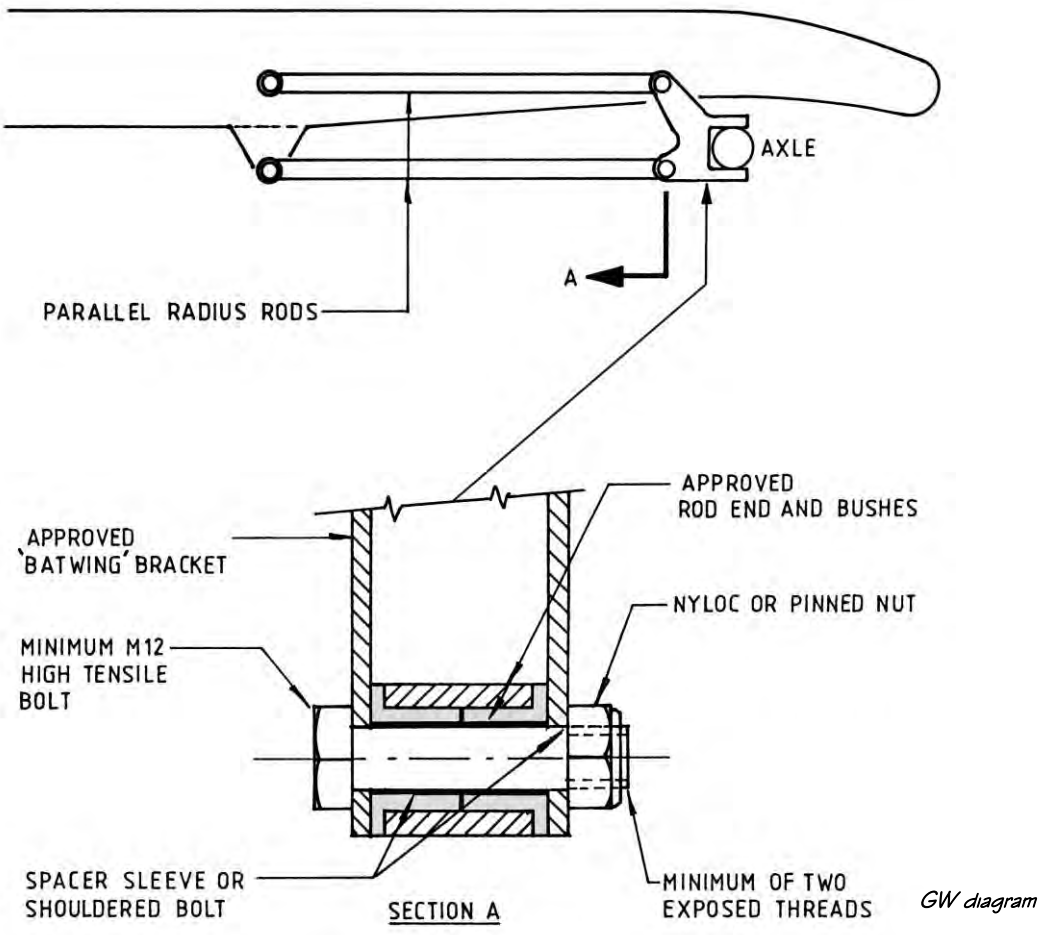


Diagram 6.2 Approved bat-wing bracket assembly design

Production solid and independent rear axle assembly requirements

6.20 Production solid axle housing suitability

6.20.1

A production vehicle solid axle housing assembly fitted to a low volume vehicle must be sourced from a donor vehicle of a similar or greater rear axle weight to that of the vehicle being modified or constructed.

6.21 Production and custom solid axle housing modification

6.21.1

Welding within the modification process of a production or custom solid axle housing in a low volume vehicle must be carried out in accordance with the welding requirements for non-critical components specified in 18.7 of 'Chapter 18 - Attachment Systems'.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.21.1, provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

6.22 Production independent rear suspension suitability

6.22.1

A production vehicle independent rear suspension assembly fitted to a low volume vehicle must be sourced from a donor vehicle of a similar or greater rear axle weight to that of the vehicle being modified or constructed.

6.23 Production independent rear suspension modifications

6.23.1

Welding within the modification process of a production independent rear suspension assembly in a low volume vehicle must be carried out in accordance with the welding requirements for non-critical components specified in 18.7 of 'Chapter 18 - Attachment Systems'.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.23.1, provided that after thorough inspection, no fatigue cracking or fracturing is evident.

6.24 Production rear axle modifications

6.24.1

A rear axle in a low volume vehicle may be re-drilled to accept a different wheel's pitch circle diameter, provided that any welding of original holes that is required due to an overlap of the new pitch circle diameter and the original holes, meets the welding requirements for non-critical components specified in 18.7 of 'Chapter 18 - Attachment Systems'.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.24.1, provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

6.24.2

The modification of a rear axle in a low volume vehicle, such as shortening, must be carried out by a person who is suitably experienced, and has a successful track record in, the field of shortening axles.

6.24.2

The process of shortening axles is also referred to as 'narrowing' axles.

Custom independent rear suspension requirements

6.25 Custom independent rear suspension design

6.25.1

A custom-built independent rear suspension assembly fitted to a low volume vehicle must be individually approved in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc), through the build approval process specified in 'Chapter 4 - Build Approval Process', to confirm that the suspension assembly incorporates design principles, material specifications, and construction methods suitable for the application, prior to commencement of construction.

6.25

'Custom' means manufactured by someone other than a reputable aftermarket manufacturer or high-volume motor vehicle manufacturer.

6.25.1

See 'Chapter 4 - Build Approval Process'.

6.26 Custom independent rear suspension construction

6.26.1

A custom-built independent rear suspension assembly fitted to a low volume vehicle, must:

(a) be constructed in such a way that any threaded section provided for adjustability is incorporated directly into the control arm material; and

(b) in the case of welded joints, have the material sections joined in such a way as to provide the greatest weld area practicable; and

6.26.1(a) & (b)

For example, use, say, schedule 80 15mm (19/32") nominal bore tube drilled & tapped directly for a 16 mm (5/8") rod end – this keeps the material spec beefy (which it needs to be), and avoids the need to weld in threaded 'spuds' to the arms to accept the rod-ends.

(c) incorporate at the outer end, either:

(i) a purpose-designed automotive ball-joint from a production vehicle of a similar corner weight; or

(ii) a custom bush assembly that is purpose-designed for carrying the corner weight of the vehicle to which the suspension is fitted.

6.26.2

Welding within the construction process of a rear suspension cross-member within a custom independent rear suspension assembly in a low volume vehicle, must be carried out in accordance with the welding requirements for non-critical components specified in 18.7 and 18.8 of 'Chapter 18 - Attachment Systems'.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.26.2, provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

6.26.3

Welding within the construction process of a custom component within a custom independent rear suspension assembly in a low volume vehicle, must be carried out:

(a) only on components manufactured from readily weldable steels, such as a low to medium tensile strength mild steel, weldable stainless steel, or chrome-moly; and

(b) in accordance with the welding requirements for critical components specified in 18.9 of 'Chapter 18 - Attachment Systems'.

6.26.3(a)

A typical weldable stainless steel is a 304 L or 316 L grade. The 'L' denotes low carbon, which means it can be successfully welded.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.26.3, provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

6.26.4

A suspension component within a custom independent rear suspension assembly in a low volume vehicle that is manufactured using a casting or forging process, must not be:

(a) heated; or

(b) bent; or

(c) welded.

6.26.4

No heating, bending, or welding of a casting or a forging is a basic engineering principle that should never be broken, except in special circumstances that are specified and controlled within this manual.

6.26.5

A custom suspension joint, such as a bushed rod end, may be fitted within a custom independent rear suspension assembly in a low volume vehicle, provided that the joint:

(a) meets the applicable requirements specified for suspension joints in 6.42.1 or 6.43.1; and

(b) is only loaded in compression or tension through its longitudinal axis.

6.26.5

Custom suspension joints include rubber or urethane-bushed aftermarket rod ends and spherical bearing rod ends.

6.26.5(b)

This means that a rod end can't be used as a bottom ball joint, because rod ends are not designed for constant side-load, and they wear faster than a proper automotive load-carrying ball-joint will.

Rear suspension hub carrier requirements

6.27 Hub carrier modifications in rear suspensions

6.27.1

A modified hub carrier assembly fitted to a low volume vehicle must be individually approved in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc), through the build approval process specified in 'Chapter 4 - Build Approval Process', prior to commencement of modification.

6.27.1

See 'Chapter 4 - Build Approval Process'.

6.28 Custom hub carrier design and construction in rear suspensions

6.28.1

A custom-built hub carrier assembly fitted to a low volume vehicle must be individually approved in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc), through the build approval process specified in 'Chapter 4 - Build Approval Process', prior to the commencement of construction.

6.28

'Custom' means manufactured by someone other than a reputable aftermarket manufacturer or high-volume motor vehicle manufacturer.

6.28.1

See 'Chapter 4 - Build Approval Process'.

Longitudinal (rear suspension) location link requirements

6.29 All radius rods in rear suspensions

6.29.1

A radius rod used to longitudinally locate an axle housing in a low volume vehicle must be either:

(a) sourced from a production vehicle of a comparable or greater weight than the vehicle being modified or constructed; or

A 'longitudinal' link is a link that locates an axle in the fore-aft direction, such as a radius rod, or four-bar system.

(b) of a satisfactory design and material specification, and maintain sufficient distance between each upper and lower pair of four-link radius rods so as to be able to resist the brake reaction loadings and torque loadings applied by the axle housing.

6.29.2

In the case of a radius rod used to locate an axle housing in a low volume vehicle, the rods must be as long as practical, so as to minimise pinion angle changes throughout the suspension's range of travel.

6.29.3

Welding within the process of radius rod attachment and axle housing modification within a low volume vehicle must be carried out in accordance with the welding requirements for non-critical components specified in 18.7 of 'Chapter 18 - Attachment Systems'.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.29.3, provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

6.29.4

A radius rod used to locate an axle housing in a low volume vehicle must be attached at both the axle housing end and the chassis end with fasteners that:

(a) are of a size that match the custom spherical bearing rod-end size guide Table 6.4; and

(b) meet the requirements specified for fasteners in 'Chapter 18 - Attachment Systems'.

6.30 Production radius rod modification in rear suspensions

6.30.1

A production vehicle radius rod that is manufactured using a forging process, and has been drilled through its neutral axis, may be fitted to a low volume vehicle that has a tare of not more than 1500 kgs (3300 lbs), provided that:

(a) the holes are drilled centrally within the radius rod; and

(b) the hole size does not exceed half of the radius rod depth throughout the length of the rod; and

6.30.1

Radius rods referred to here are primarily those used by high volume vehicle manufacturers (particularly Ford) from shortly after the turn of the century to the late 1940s, and beyond for commercial vehicles.

It is strongly recommended that when drilling a rear radius rod, the rod be reinforced down its length (so as to effectively turn it into a ladder bar) to prevent bending under severe loading.

'Tare' is the unladen weight of the vehicle.

Drilled through the 'neutral axis' means drilled through the sides (on a horizontal plane), rather than from top to bottom.

(c) the holes are 'tubed' with a mild steel material of not less than 3 mm (1/8") in wall thickness; and

(d) the welding of the tubing into the radius rods is carried out in accordance with requirements specified in 18.7 and 18.8 of Chapter 18 - Attachment Systems'; and

(e) not less than 30 mm (1 3/16") of radius rod material remains between the holes.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.30.1(d), provided that after thorough inspection, no fatigue cracking or fracturing is evident.

6.31 Split production radius rods in rear suspensions

6.31.1

Production radius rods may be split away from their original single central mounting point and attached to new mounting points on each side of the chassis of a low volume vehicle, provided that:

(a) flexible bushes or tie-rod ends that allow a substantial amount of movement are fitted at the chassis mounts; and

(b) the vehicle to which the split production radius rods are fitted has minimal suspension travel.

6.31.1

A split production radius rod fitted to an axle housing without compliance at the chassis end will bind, and possibly break. Chassis end bushes where a split radius rod attaches, must be substantially thicker than in normal bush situations and need to be along the lines of those found on Jaguar IRS radius rods.

6.32 Hairpin radius rods in rear suspensions

6.32.2

A low volume vehicle may be fitted with hairpin radius rods to locate an axle housing, provided that:

(a) the hairpin radius rods are attached at the axle housing with custom spherical bearing rod ends or custom clevis joints that meet the requirements specified in 6.43.1 or 6.45.1; and

(b) the hairpin radius rods are attached at the chassis with custom bushed rod ends or tie-rod ends that meet the requirements specified in 6.42.1 or 6.44.1; and

(c) the vehicle to which the hairpin radius rods are fitted has minimal suspension travel.

6.32.2

A hairpin radius rod fitted to an axle housing without compliance at the chassis end will bind, and possibly break.

Chassis end bushes where a hairpin radius rod attaches must be substantially thicker than in normal bush situations and need to be along the lines of those found on Jaguar IRS radius rods.

6.33 Ladder bar radius rods in rear suspensions

6.33.1

A low volume vehicle may be fitted with ladder bar radius rods to locate an axle housing provided that:

(a) the ladder bar radius rods are attached at the axle housing with custom spherical bearing rod ends or custom clevis joints that meet the requirements specified in 6.43.1 or 6.45.1; and

(b) the ladder bar radius rods are attached at the chassis with custom bushed rod ends or tie-rod ends that meet the requirements specified in 6.42.1 or 6.44.1.

(c) the vehicle to which the ladder bar radius rods are fitted has minimal suspension travel.

6.33.1

A ladder bar radius rod fitted to an axle housing without compliance at the chassis end will bind, and possibly break. Chassis end bushes where a ladder bar attaches to the chassis must be substantially thicker than required in normal bush situations, and needs to be along the lines of those found on Jaguar IRS radius rods.

6.33.2

In the case of a ladder bar radius rod system operating in conjunction with longitudinal semi-elliptic leaf springs, the:

(a) pivot points of the ladder bar radius rods must be parallel with the front spring hangers to allow full suspension movement; and

(b) ladder bar radius rod ends must incorporate:

(i) flexible bushes at the chassis end of the ladder bar radius rod; and

(ii) custom bushed rod ends at the diff housing end of the ladder bar radius rod.

6.33.2

This is to prevent the ladder bar restricting the leaf spring movement, and binding the diff housing.

6.34 Parallel four-link radius rods in rear suspensions

6.34.1

Four-link radius rods used to locate an axle housing in a low volume vehicle must incorporate geometry that ensures against excessive pinion rotation as the axle housing travels through its arc during suspension travel.

6.34.1

A good 4-bar set-up will have about 150 mm (6") between the top and bottom bars at the diff end, and about 125 mm (5") between the top and bottom bars at the chassis end.

6.34.2

Four-link radius rods used to locate an axle housing in a low volume vehicle must be manufactured from a material specification in accordance with Table 6.2.

6.34.2

Table 6.2 assumes the rod is of a 'normal' range of length, between 350 mm (14") and 700 mm (28 ½"). Longer rods should be up-sized.

VEHICLE TYPE	LOW POWER OUTPUT	HIGH POWER OUTPUT
▪ Lotus 7 replica ▪ Light-weight space-frame sports or vintage special	22 mm (7/8") OD x 1.6 mm (1/16") wall thickness, ERW or seamless tube	22 mm (7/8") OD x 2.0 mm (5/64") wall thickness, ERW or seamless tube
▪ Heavy-weight space-frame sports special ▪ Medium-weight ladder-chassis sports car (MGTF replica) ▪ Light-weight hot rod (T-bucket, f-glass roadster) ▪ Small unit-construction sedan (Civic, Mazda 323)	22 mm (7/8") NB schedule 80 x 4.2 mm (11/64")	22 mm (7/8") NB schedule 80 x 4.2 mm (11/64")
▪ Heavy-weight ladder-chassis sports car (Cobra) ▪ Medium-weight hot rod (steel coupe, pick-up) ▪ Large unit-construction sedan (Camaro, Falcon, Commodore, Skyline)	22 mm (7/8") NB schedule 80 x 4.2 mm (11/64")	25 mm (1") NB schedule 80 x 4.2 mm (11/64")
▪ Heavy-weight hot rod (30s & 40s sedan) ▪ Full size body/chassis car (50s & 60s USA sedan)	25 mm (1") NB schedule 80 x 4.2 mm (11/64")	25 mm (1") NB schedule 80 x 4.2 mm (11/64")

Table 6.2 Parallel four-link radius rod material guide table

6.35 Triangulated four-link radius rods in rear suspensions

6.35.1

The angle at which a non-parallel radius rod used to locate a rear axle housing in a low volume vehicle is positioned, must be sufficient to locate the rear axle housing transversely.

Transverse (front and rear) location link requirements

6.36 All transverse links in front suspensions

6.36.1

Where radius rods are used to locate a front axle in a low volume vehicle, some method of transverse location must be provided, except in the case of:

(a) a triangulated four-bar system; or

(b) a radius rod system with a transverse leaf spring.

Table 6.2

The dimensions specified in Table 6.2 are based on the use of mild steel tubing. Aluminium tubing should be avoided for road use, unless top quality material is used, and the diameter is substantially increased in order to provide strength equal to or better than the mild steel equivalent.

6.35.1

Production vehicles using triangulated four link systems should be studied to provide a guide on the amount of angularity that is necessary to provide transverse support.

6.36

See more information on next page.

6.37 All transverse links in rear suspensions

6.37.1

Where radius rods are used to locate a rear axle housing in a low volume vehicle, some method of transverse location must be provided, except in the case of:

(a) a triangulated four-bar system; or

(b) a radius rod system with a transverse leaf spring.

6.37.2

A transverse link used to laterally locate an axle housing in a low volume vehicle must be either:

(a) sourced from a production vehicle of a comparable or greater weight than the vehicle being modified or constructed; or

(b) of a design and material specification that will withstand the suspension and braking reaction loads that the rods are subjected to.

6.37.3

Welding within the process of transverse link attachment and axle housing modification within a low volume vehicle must be carried out in accordance with the welding requirements for non-critical components specified in 18.7 of 'Chapter 18 - Attachment Systems'.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.37.3, provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

6.37.4

A transverse link used to locate an axle housing in a low volume vehicle must be attached at both the axle housing end and the chassis end with fasteners that:

(a) are of a size specified in the custom spherical bearing rod end size guide Table 6.4; and

(b) meet the requirements specified for fasteners in 'Chapter 18 - Attachment Systems'.

6.38 Panhard rods in front and rear suspensions

6.38.1

A panhard bar fitted to a low volume vehicle must:

6.36

'Transverse link' means something that runs sideways across the vehicle, to secure the axle laterally in the chassis, like a panhard bar, or watts linkage.

6.36.1

6.36.1 does not include the situation where a cross-steer system is used. In such cases, a panhard bar must always be used.

'Cross-steer' is an 'east-west' steering system which directly links the steering box drop arm to the left side steering arm.

6.36.1(b)

A transverse leaf spring, although not ideal, can provide transverse location.

(a) be as straight as can practicably be designed and fitted; and

(b) be as long as can practicably be designed and fitted; and

(c) have each of its ends positioned as closely as practicable to the horizontal plane, or be parallel to, the axle or axle housing.

6.38.1(b)

Achieving the maximum possible length for the panhard bar is extremely important for optimum handling.

6.38.1(c)

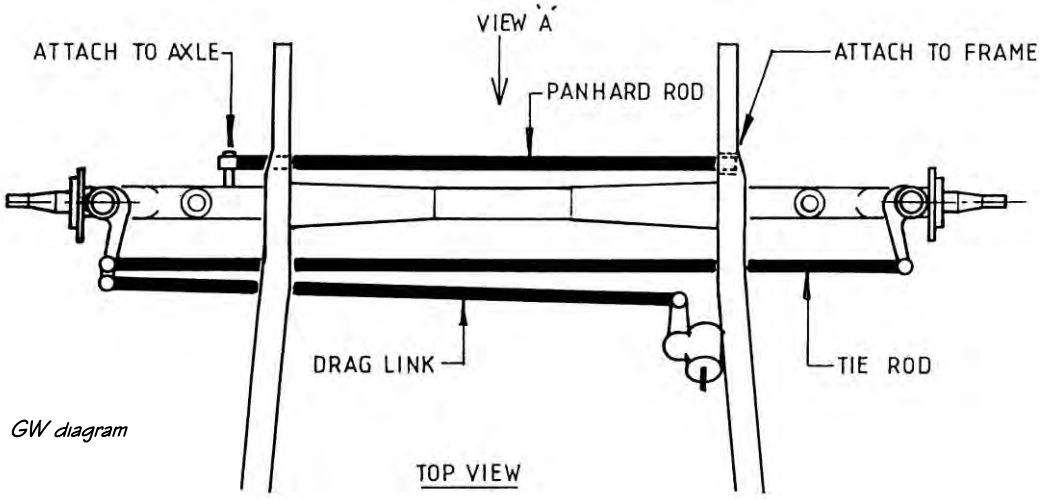
This includes the pick-up points at each end of the panhard bar.

6.38.2

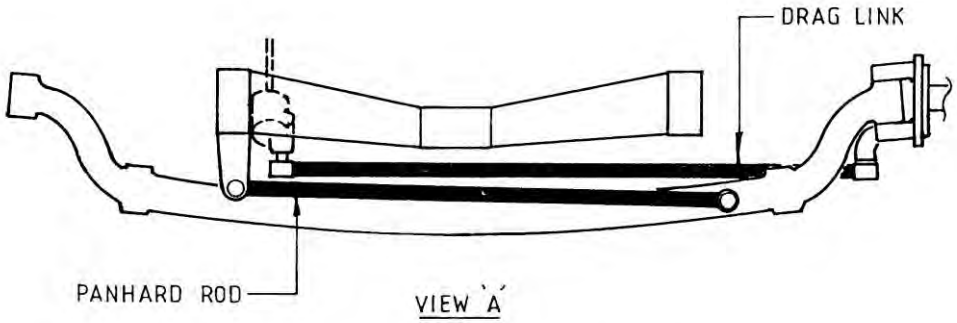
A panhard bar fitted to a low volume vehicle must attach to the chassis and axle housing with either:

(a) custom bushed rod ends that meet the requirements specified in 6.42.1; or

(b) custom spherical bearing rod ends that meet the requirements specified in 6.43.1.



GW diagram



GW diagram

NOTE: PANHARD ROD MUST BE ANCHORED TO THE CHASSIS ON THE STEERING BOX SIDE.

Diagram 6.3 Panhard bar attachment

6.38.3

A panhard bar mounted to the front of a low volume vehicle, must be attached at the chassis on the same side of the vehicle as that upon which the steering box is positioned. (see Diagram 6.3)

6.38.4

In the case of a panhard bar fitted to both the front and rear of a low volume vehicle, the panhard bar must be attached to the chassis on the same side at both the front and the rear ends of the vehicle.

6.39 Watts linkage rods in front and rear suspensions

6.39.1

Each bar within a watts linkage rod fitted to a low volume vehicle, must, at normal ride height:

(a) be positioned as closely as practicable to:

(i) the horizontal plane, or parallel to the axle or axle housing; and

(ii) parallel to each other;

and

(b) be as long as can practicably be designed and fitted.

6.39.1(a)

This includes the pick-up points at each end of the watts linkage rod.

6.39.1(b)

Achieving the maximum possible length for the watts linkage is extremely important for optimum handling.

6.39.2

A watts linkage rod fitted to a low volume vehicle must attach to the chassis and axle housing with either:

(a) custom bushed rod ends that meet the requirements specified in 6.42.1; or

(b) custom spherical bearing rod ends that meet the requirements specified in 6.43.1

6.40 Diagonal track locator rods in rear suspensions

6.40.1

A diagonal track locator, which is positioned between the rear of one lower four-link radius rod and the front of the other lower four-link radius rod, if fitted to a low volume vehicle, must incorporate fasteners and bracketry within the attachment system that are substantially stronger than the equivalent systems typically employed in a drag racing application.

6.40.1

This is a common set-up on drag racing vehicles. However, the joints typically used to attach a diagonal track locator in a drag car are not designed to withstand the cornering loads of a road-going vehicle.

Suspension joint (front and rear) requirements

6.41 Production ball-joints

6.41.1

A vertically loaded suspension joint fitted to a low volume vehicle must be a purpose-designed load-bearing automotive ball-joint designed to support the corner weight of the vehicle in which it is positioned.

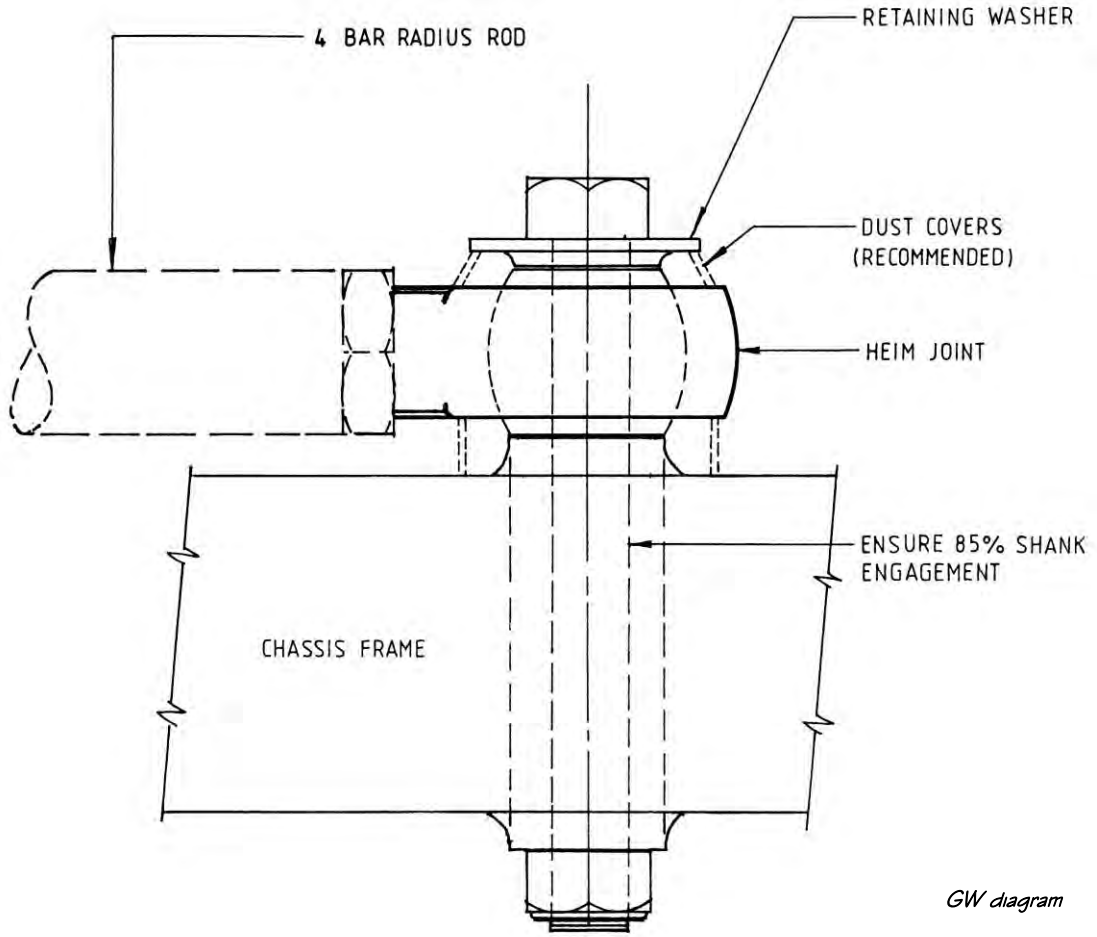


Diagram 6.4 Custom spherical bearing rod end retaining washers

6.42 Custom bushed rod ends

6.42.1

A custom adjustable, or non-adjustable bushed rod end used in a low volume vehicle must incorporate:

(a) purpose designed rubber or urethane bushing; and

(b) a steel inner sleeve; and

(c) in the case of a single-shear attachment of the rod end, a purpose designed pull-out prevention retaining washer. (see Diagram 6.4)

6.42.1(c)

Double-shear is always a preferred attachment method.

6.43 Custom spherical bearing rod ends

6.43.1

A custom spherical bearing rod end fitted to a low volume vehicle must:

6.43.1

Spherical bearing rod ends are commonly known as 'rose' joints or 'heim' joints.

(a) be of premium quality, having a radial load-rating appropriate to the rod end size of not less than that specified in Table 6.3; and

(b) be positioned in such a way that binding of the end cannot occur throughout the full range of suspension travel; and

(c) incorporate sufficient thread engagement to ensure the rod end is securely held in position; and

6.43.1(c)

See details on ensuring sufficient thread engagement in 'inspection holes' in the 'Useful Information' section.

(d) be injected with a high quality flexible lining material such as Teflon or Kevlar; and

(e) incorporate a retaining washer to prevent pull-out if the end becomes worn; (see Diagram 6.4) and

(f) incorporate a shank size and a bolt size in accordance with Table 6.4.

6.43.1(d)

This specifically precludes the use of brass-lined rod ends.

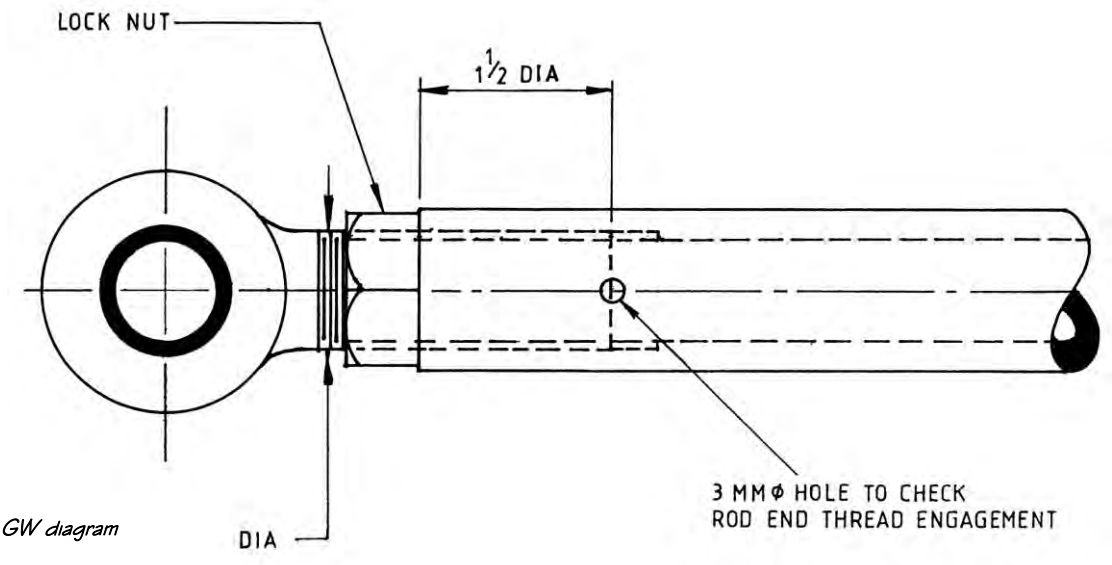


Diagram 6.5 Custom spherical bearing rod end inspection hole

ROD END SIZE	LOAD-RATING
▪ 10 mm (3/8")	1770 kg (3900 lb) radial load
▪ 11 mm (7/16")	1900 kg (4200 lb) radial load
▪ 12 mm (1/2")	3020 kg (6650 lb) radial load
▪ 16 mm (5/8")	3340 kg (7350 lb) radial load
▪ 19 mm (3/4")	5230 kg (11,500 lb) radial load

Table 6.3 Custom spherical bearing rod end (radial) load-rating table

VEHICLE TYPE	VEHICLE WEIGHT RANGE	SHANK SIZE	BOLT SIZE
▪ Lotus 7 replica ▪ Light-weight space-frame sports or vintage special	500 – 800 kg (1100 – 1760 lb)	11 mm (7/16")	11 mm (7/16")
▪ Heavy-weight space-frame sports special ▪ Medium-weight ladder-chassis sports car (MGTF replica) ▪ Light-weight hot rod (T-bucket, f-glass roadster) ▪ Small unit-construction sedan (Civic, Mazda 323)	800 – 1150 kg (1760 – 2530 lb)	12 mm (1/2")	12 mm (1/2")
▪ Heavy-weight ladder-chassis sports car (Cobra) ▪ Medium-weight hot rod (steel coupe, pick-up) ▪ Large unit-construction sedan (Camaro, Falcon, Commodore, Skyline)	1150 – 1500 kg (2530 – 3300 lb)	16 mm (5/8")	12 mm (1/2")
▪ Heavy-weight hot rod (30s & 40s sedan) ▪ Full size body/chassis car (50s & 60s USA sedan) ▪ Full-size four-wheel drive vehicles	1500 – 2200 kg (3300 – 4800 lb)	16 mm (5/8")	16 mm (5/8")

Table 6.4 Custom spherical bearing rod end size-guide table

6.44 Tie-rod ends

6.44.1

A tie-rod end may be used in a low volume vehicle for the attachment of split radius rods or hairpin radius rods to the chassis at the front or the rear of the vehicle, provided that:

(a) a male thread size of not less than 17 mm (11/16") is used; and

(b) there is sufficient thread-depth of the tie-rod end into the radius rod; and

(c) an attachment boss at the chassis has:

(i) a correctly machined taper to accept the tie-rod end; and

(ii) sufficient depth so as to accommodate all of the taper in the tie-rod end; and

6.45 Custom clevis joints

6.45.1

A custom clevis joint used in a low volume vehicle must be:

(a) purpose-designed for automotive use; and

(b) of a size appropriate for the application.

6.46 Suspension joint bushings

6.46.1

A bushing incorporated within a suspension joint in a low volume vehicle must be manufactured from a material that is durable, has shock-loading resistance characteristics, and that will retain its shape and position within the joint, throughout all normal vehicle use.

6.46.1

Typical materials regarded as good are urethanes, and rubbers that are supplied specifically for automotive bushing purposes.

Suspension geometry requirements

6.47 General geometry requirements

6.47.1

A low volume vehicle that has undergone significant changes to the suspension system must feature no abnormal suspension geometry, and be aligned so as to provide satisfactory handling characteristics, and ensure against excessively shortened tyre life.

6.47.2

Moving components and systems fitted to a low volume vehicle which are affected by suspension travel, must not be detrimentally affected at extremes of suspension travel by exceeding the operating limits specified by the equipment manufacturer, including:

(a) *binding or excessive angularity of ball-joints, swivel-joints or constant velocity-joints; or*

(b) *binding or excessive angularity of steering arms or tie-rod ends; or*

(c) *binding or shortening the normal working life of drive-shaft universals.*

6.47.3

A front suspension system fitted to a low volume vehicle must incorporate provision for the correct adjustment and alignment of camber, toe-in, and toe-out.

6.48 Caster angle geometry

6.48.1

Positive caster is required to be incorporated within the front suspension of a low volume vehicle, as specified in 7.34 of 'Chapter 7 - Steering Systems'.

6.48.1

The subject of caster, and its effects, is covered in detail in the 'Useful Information' section at the end of 'Chapter 7 – Steering Systems'

6.49 Production independent rear suspension geometry

6.49.1

A production vehicle independent rear suspension assembly fitted to a low volume vehicle must:

(a) be attached to the chassis using components and attachment methods that duplicate or improve the suspension geometry of the donor vehicle; and

(b) not bind throughout all normal operating suspension travel; and

(c) in the case of a Jaguar independent rear suspension system from the 1960s to 1980s era, follow the installation and geometry principles outlined in the applicable Low Volume Vehicle Technical Association (Inc) Information Sheet.

6.49.1

The Jaguar IRS has caused a lot of problems over the years, through incorrect installations. The LVVTA (Inc)'s Information Sheet provides the necessary information to get the Jaguar IRS installation right. This is available from the LVVTA (Inc)'s website, down-loadable free of charge at www.lvvta.org.nz

Air-bag suspension system requirements

6.50 Air-bag system installation

6.50.1

An air-bag system fitted to a low volume vehicle must be:

(a) an appropriate selection for the vehicle type and weight; and

(b) designed and installed in accordance with the air-bag manufacturer's specifications.

6.50.2

An air-bag system fitted to a low volume vehicle must be designed and installed in such a way that either:

(a) the air-bag system is only able to be operated whilst the vehicle is stationary; or

(b) the air-bag system can be operated whilst the vehicle is in motion, provided that:

(i) the ride-height of any part of the vehicle is electronically prevented from being adjusted or changed when the vehicle is being driven over a speed of 20 kph (12 mph); and

(ii) the vehicle automatically reverts to its pre-determined correct ride-height when a speed sensor determines that the vehicle is traveling faster than 20 kph (12 mph).

6.50.3

An air-bag system fitted to a low volume vehicle must be designed and installed in such a way that the air-bag system:

(a) can raise or lower the vehicle in the fore-aft, and side-to-side combination, but cannot raise an individual corner of the vehicle; and

(b) cannot enable the vehicle to 'bounce' or 'hop' on its suspension.

6.50.4

An air-bag incorporated within an air-bag system fitted to a low volume vehicle must be installed in such a way that, at normal ride-height:

(a) the top and bottom mounting plates to which the air-bag attaches are as close as practicable to parallel with each other; and

(b) the air-bag as much as practicable, maintains its intended shape.

6.50.2

This requirement is to prevent the vehicle from being driven at any stance that could cause the vehicle to be unsafe to drive, through excessive or insufficient ride-height, or incorrect steering or suspension geometry.

6.50.2 (cont'd)

A system used to meet the requirements specified in 6.50.2(b)(i) must be as resistant to post-certification tampering as possible. Park-brake activated systems are not permitted.

6.50.3

It is particularly necessary to prevent the vehicle from being twisted diagonally, which causes major stress and damage to the vehicle structure over time.

6.50.4

This means that the bag does not 'banana' due to incorrect platform positioning.

6.50.5

An air-bag system fitted to a low volume vehicle must be designed and installed in such a way that under full suspension droop, the air-bag cannot:

(a) extend beyond the air-bag manufacturer's specifications; or

(b) dislodge or come out.

6.51 Vehicle ride-height with air-bag systems

6.51.1

An air-bag system fitted to a low volume vehicle must be designed and installed in such a way that, when the vehicle is being driven, the ride-height of the vehicle cannot be altered.

6.51.2

An air-bag system fitted to a low volume vehicle must be designed and installed in such a way that, when the vehicle is being driven, the ride-height of the system can only be positioned at a setting which ensures that:

(a) all normal steering and suspension requirements are maintained; and

(b) all suspension arms are in the neutral plane; and

(c) the vehicle's position in relation to the road surface is not offset either side to side, diagonally, or significantly offset front to rear; and

(d) the vehicle's ride-height is not so high that it could become unstable; and

(e) the vehicle's ride-height is not so low that the vehicle no longer meets the scrub-line requirements specified in 7.37 of 'Chapter 7 – Steering Systems'.

6.51.2(b)

Suspension arms include all axle locaters including radius rods, wishbone arms, panhard bars, and watts linkage bars.

6.51.2(c)

This means that the vehicle can have a normal 'rake', but maintains a 'flat' stance side to side and diagonally.

An LVV Certifier is responsible for assessing the minimum and maximum height ranges throughout which the vehicle can be safely operated, and having these recorded on the LVV certification plate.

6.52 Air-bag system dampers and bump-stops

6.52.1

Each corner of a low volume vehicle to which an air-bag system is fitted, must incorporate an effective damping system, either:

(a) as part of the air-bag system; or

(b) in the case of an air-bag system which does not incorporate integral dampers, in addition to the air-bag system.

6.52.2

An air-bag system fitted to a low volume vehicle must be designed and manufactured in such a way that:

(a) effective bump-stops similar to those expected in a spring and shock-absorber combination are incorporated within the system that are either:

(i) separate units mounted externally from the air-bag; or

(ii) incorporated internally within the air-bag;

and

(b) in the event of a failure of all or any part of the system, bump-stops will prevent the vehicle from being able to be driven at a ride-height below the specified minimum safe setting.

6.52.2(a)

An air-bag system is typically a lot harder on bump-stops than a conventional suspension system. Therefore, extra attention should be put into trying to use the best possible bump-stops, and the vehicle owner should be prepared to replace the bump-stops more regularly than on a conventional suspension system.

6.53 Air-bag system air supply

6.53.1

An air-bag incorporated within an air-bag system fitted to a low volume vehicle must be either:

(a) a bag supplied as part of a complete kit manufactured by a reputable company that manufactures purpose-designed automotive suspension systems; or

(b) made from a material that can be proven through documented evidence to be capable of withstanding the pressures and loads to which it will be subjected, during all aspects of the system's intended use.

6.53.2

An air-bag system fitted to a low volume vehicle must be installed in a such a way that, when the vehicle is being driven:

(a) each air-bag maintains its pressure; and

(b) no transfer of air between individual corners of the vehicle can occur.

6.53.2

In a 4-way mode, the system will prevent air transfer from side to side or front to back, which ensures against increased body roll from unequal and changing loads.

6.53.3

An air-bag system fitted to a low volume vehicle must incorporate:

(a) an air supply tank that is a purpose-designed pressure vessel that:

(i) is mounted securely to the vehicle structure in a safe position; and

(ii) complies with the appropriate pressure vessel requirements;

and

(b) air-valves, lines, fittings, and hoses that are:

(i) securely attached; and

(ii) protected from moving components; and

(iii) adequately shielded from heat; and

(iv) rated for operational use at a pressure of not less than that at which the system operates;

and

(c) an external auxiliary fill valve that will enable re-filling from an external compressor.

6.53.3(c)

This is to enable a vehicle to have its air system re-filled from a compressor at a petrol station in order to maintain normal suspension system height and operation in the event of a slow leak.

6.53.4

An air-bag system fitted to a low volume vehicle that incorporates a pressure bottle, must incorporate an independent relief valve or pressure switch to prevent the air supply tank from over-pressurising.

6.53.4

'Pressure bottle' generally means a dive bottle. This requirement is in case of a failure of the bottle's pressure regulator.

6.54 Chassis and suspension modifications (for air-bags)

6.54.1

Modifications to the chassis and suspension of a low volume vehicle fitted with air-bag suspension must:

(a) incorporate adequate reinforcing where metal removal has occurred on any suspension arms, so as to ensure the suspension arms have not been weakened as a result of the modification; and

(b) incorporate adequate remaining chassis strength where metal removal has occurred so as to ensure the chassis has not been weakened as a result of the modification; and

(c) have at least 5 mm (13/64") clearance between brake lines and moving parts when the hydraulic system is at maximum or minimum level; and

(d) have adequate drive-shaft clearance from the chassis when the airbag system is at maximum or minimum level; and

(e) have adequate clearance between the wheels and tyres and suspension or bodywork at any stage of suspension travel; and

(f) incorporate flexible brake hoses that are of such a length, and are so positioned and secured, that they cannot contact or become pinched by any part of the vehicle's structure or components, throughout the suspension system's full range of suspension travel; and

(g) not have any components mounted lower than that specified for steering system scrub-line geometry in 7.37 'Chapter 7 - Steering Systems'.

6.54.1(e)

It is accepted that in 'limp-home mode' with total air-bag failure, the steering lock may be limited due to rubbing.

6.54.2

Shock absorbers fitted to a low volume vehicle with an air-bag suspension system, must, if repositioned or remounted, be:

(a) mounted using a mounting and attachment system that is capable of withstanding the loads that will be imposed on it through all normal driving operation and air-bag action; and

(b) positioned in such a way as to provide maximum damping effect; and

(c) mounted in such a way so as:

(i) to duplicate or improve the original mounting system design; and

(ii) not to bind or interfere with any other part of the vehicle.

6.54.3

A low volume vehicle fitted with an air-bag suspension system must incorporate a mudguard over each wheel and tyre.

6.54.3

'Mini-trucks' with airbags or hydraulics may use the deck tonneau cover or hard-bed as its mudguards for the rear wheels.

Hydraulic suspension system requirements

6.55 Hydraulic suspension design principles

6.55.1

A hydraulically-actuated adjustable ride-height suspension system may be fitted to a low volume vehicle provided that:

(a) the vehicle incorporates a spring for each wheel, that is:

6.55.1

Put in simplest terms, a hydraulic suspension can only be LVV certified if:

- the vehicle has a spring with a suitable rate for normal road use; and
- a working shock absorber for each wheel; and
- the hydraulic system cannot be operated when the vehicle exceeds 20 kph (12 mph) and
- the system cannot 'bounce' or 'hop' the car.

(i) capable of providing sufficient suspension bump travel for the vehicle to be able to be driven safely; and

(ii) of a rate that enables the vehicle to absorb all road irregularities in a normal manner;

and

(b) the vehicle incorporates an operative and effective shock absorber for each wheel, that is capable of adequately damping springing operation; and

(c) adequate safeguards are incorporated to ensure that the vehicle retains its normal road handling, braking and steering performance when used on-road; and

(d) the design is such that safety components are not overstressed during extreme suspension travel when off-road.

6.55.1(a)(i)

Minimum sufficient bump travel is, as a very general rule of thumb, considered to be 40 mm (1 9/16") for a medium weight vehicle.

6.55.2

A hydraulically-actuated adjustable ride-height suspension system may only be fitted to a low volume vehicle that incorporates coil suspension.

6.55.2

This means hydraulics cannot be used in conjunction with leaf spring suspension systems.

6.56 Hydraulic suspension geometry

6.56.1

A hydraulically-actuated adjustable ride-height suspension system fitted to a low volume vehicle must not allow:

(a) maximum suspension component and ball-joint angles to be exceeded at any stage of suspension travel; and

(b) maximum drive-shaft universal joint operating angles to be exceeded at any stage of suspension travel.

6.56.2

A hydraulic actuator incorporated within an adjustable ride-height system fitted to a low volume vehicle must be installed in such a way that, at all ride-heights:

(a) the actuator and spring locator cup acts as squarely as can be achieved on the spring; and

(b) the spring is located so that it cannot fall out during ram operation; and

(c) the top and bottom mounting plates to which a ram/spring combination attaches are as close as practicable to parallel with each other; or

(d) a swivel mounting is used on the lower end where the actuator is mounted to the axle or suspension arm.

6.57 Vehicle ride-height with hydraulic suspension

6.57.1

A hydraulic suspension system fitted to a low volume vehicle must be designed and installed in such a way that either:

(a) the hydraulic suspension system is only able to be operated whilst the vehicle is stationary; or

(b) the hydraulic suspension system can be operated whilst the vehicle is in motion, provided that:

(i) the ride-height of any part of the vehicle is electronically prevented from being adjusted or changed when the vehicle is being driven over a speed of 20 kph (12 mph); and

(ii) the vehicle automatically reverts to its pre-determined correct ride-height when a speed sensor determines that the vehicle is traveling faster than 20 kph (12 mph).

6.57.2

A hydraulic suspension system fitted to a low volume vehicle must be designed and installed in such a way that, when the vehicle is being driven, the ride-height of the system can only be positioned at a setting which ensures that:

(a) all normal steering and suspension requirements are maintained; and

(b) all suspension arms are as close as practicable to the neutral plane; and

(c) the vehicle's position in relation to the road surface is not offset either side to side, diagonally, or significantly offset front to rear; and

(d) the vehicle's ride-height is not so high that it could become unstable; and

(e) the vehicle's ride-height is not so low that the vehicle no longer meets the scrub-line requirements specified in 7.37 of 'Chapter 7 - Steering Systems'.

6.56.2(c)

It is accepted that there will always be some offset loading as any suspension system moves throughout its arc. However, the spring and ram platforms must be set up squarely at normal ride-height, so that the ram or ram/spring combination does not 'banana' during suspension travel.

6.57.1

A LVV Certifier will need to assess the approved operating ride-height, and have this recorded on the LVV Certification Plate.

A system used to meet the requirements specified in 6.57.1(b)(i) must be as resistant to post-certification tampering as possible. Park-brake activated systems are not permitted.

6.57.2(b)

Suspension arms include all axle locaters including radius rods, wishbone arms, panhard bars, and watts linkage bars.

6.57.2(c)

This means that the vehicle can have a normal 'rake', but maintains a 'flat' stance side to side and diagonally.

6.58 Hydraulic system bump-stops

6.58.1

A low volume vehicle must be fitted with bump-stops that:

(a) are similar in design to those expected in a normal non-hydraulic suspension spring and shock-absorber combination, that are separate units mounted externally from the hydraulic rams; and

(b) will operate in such a way that upon a total hydraulic system failure, sufficient clearance between the vehicle's wheels and tyres, and the suspension, steering and body will exist, so that basic controllability of the vehicle will be maintained.

6.58.1(a)

A hydraulic system is typically a lot harder on bump-stops than a conventional suspension system. Therefore, extra attention should be put into trying to use the best possible bump-stops, and the vehicle owner should be prepared to replace the bump-stops more regularly than on a conventional suspension system.

6.58.1(b)

Upon a hydraulic system failure, at 'collapsed' height, a vehicle with hydraulic suspension must still maintain sufficient driveability to be able to be pulled onto a transporter, or operated in a 'limp home' mode.

6.59 Hydraulic system oil supply

6.59.1

A hydraulic ram incorporated within a hydraulic suspension system fitted to a low volume vehicle must be a ram that is either:

(a) supplied as part of a complete kit manufactured by a reputable company that manufactures purpose-designed automotive suspension systems; or

(b) can be proven through documented testing evidence to be capable of withstanding the pressures and loads to which it will be subjected, during all aspects of the system's intended use.

6.59.2

A hydraulic system fitted to a low volume vehicle must be installed in a such a way that, when the vehicle is being driven at over 20 kph (12 mph):

(a) each hydraulic ram maintains its pressure; and

(b) no transfer of oil between individual corners of the vehicle can occur.

6.59.2

In a 4-way mode, the system will prevent oil transfer from side to side or front to back, which ensures against increased body roll from unequal and changing loads.

6.59.3

A hydraulic system fitted to a low volume vehicle must incorporate:

(a) a separate pump for each axle; and

6.59.3

This is to overcome differences in front and rear axle weights.

(b) an oil supply reservoir that is a purpose-designed vessel that:

(i) is mounted securely in a safe position; and

(ii) holds at least 25% more fluid than the combined volume of all the hydraulic rams.

6.59.4

Valves, lines, fittings, and hoses that are incorporated within a hydraulic system fitted to a low volume vehicle must be:

(a) securely attached using purpose-designed clamping systems at maximum intervals of 300 mm (12"); and

(b) protected from the road surface, road debris, and jacks; and

(c) protected from moving components; and

(d) adequately shielded from heat; and

(e) purpose-designed components that are rated for operational use at a pressure of not less than that at which the system operates.

6.59.4(c)

Lines and hoses must not be mounted on the underside of chassis or sub-frame rails.

6.59.4(e)

Such equipment needs to be rated for a minimum of 3000 psi (20,670 kPa).

6.59.5

Fluid within a hydraulic suspension system that passes through the passenger compartment of a low volume vehicle must be contained within hard-line only.

6.60 Hydraulic system electrical power

6.60.1

Where a hydraulic suspension utilises banks of batteries for hydraulic pump operation, they must:

(a) operate at a maximum of 48 volts; and

(b) operate through relays that are capable of withstanding the electrical loads being applied; and

(c) be securely retained in a structure specifically designed for the weight and load of the batteries being used, and

(d) have some method of preventing acid spills from entering the passenger compartment of the vehicle; and

(e) are sealed and ventilated where charging and subsequent gas emission may occur while the vehicle is operating; and

6.60.1(a)

The LVV Certifier must measure the as-installed pump supply voltage, which is not to exceed 48 volts, or 4 12-volt batteries.

The LVV Certifier should be aware of the speed of the system, and satisfy himself that the system cannot operate at such a speed as to enable 'hopping' or 'bouncing'.

6.60.1(c)

On separate body/chassis vehicles, such structures should mount directly to the chassis.

(f) have a mechanical master isolation switch within reach of the driver that isolates the power supply to the hydraulic motors and motor controls; and

(g) be safely wired and protected from short circuits, and

(h) have electrical equipment such as pump motors and solenoids isolated from the fuel tank and system.

6.60.1(f)

A switch linked to a high current DC isolator relay is preferred, such as those used in electric fork-hoists.

6.61 Chassis and suspension system modifications (for hydraulic systems)

6.61.1

Modifications to the chassis and suspension of a low volume vehicle fitted with hydraulic suspension must:

(a) incorporate adequate reinforcing where metal removal has occurred on any suspension arms, so as to ensure the suspension arms have not been weakened as a result of the modification; and

(b) incorporate adequate remaining chassis strength where metal removal has occurred so as to ensure the chassis has not been weakened as a result of the modification; and

(c) have at least 5 mm (13/64") clearance between brake lines and moving parts when the hydraulic system is at maximum or minimum level; and

(d) have adequate drive-shaft clearance from the chassis when the hydraulic system is at maximum or minimum level; and

(e) have adequate clearance between the wheels and tyres and suspension or bodywork at any stage of suspension travel; and

6.61.1(e)

It is accepted that in 'limp-home mode' with total hydraulic failure, the steering lock may be limited due to rubbing.

(f) incorporate flexible brake hoses that are of such a length, and are so positioned and secured, that they can not contact or become pinched by any part of the vehicle's structure or components, throughout the suspension system's full range of suspension travel; and

(g) not have any components mounted lower than that specified for steering system scrub-line geometry in 7.37 'Chapter 7 - Steering Systems'.

6.61.2

Shock absorbers fitted to a low volume vehicle with a hydraulic suspension system, must, if repositioned or remounted, be:

(a) mounted using a mounting and attachment system that is capable of withstanding the loads that will be imposed on it through all normal driving operation and hydraulic action; and

(b) positioned in such a way as to provide maximum damping effect; and

(c) mounted in such a way so as:

(i) to duplicate or improve the original mounting system design; and

(ii) not to bind or interfere with any other part of the vehicle.

Additional requirements for all suspension systems

6.62 Coil-over shock absorber requirements

6.62.1

A coil-over shock absorber system incorporated within the rear suspension of a low volume vehicle, must be attached using either:

(a) the double-shear attachment method; or

(b) the single-shear attachment method that incorporates:

(i) a load-bearing surface that supports the coil-over shock absorber assembly which is incorporated integrally with the attachment bracket; and

(ii) an attachment bracket manufactured from a suitable material, of a thickness of not less than 5 mm 13/64"), and with adequate gusseting or reinforcement to prevent bending; and

(iii) a mounting stud that has a diameter of not less than that specified in Table 6.4; and

(iv) a spacer sleeve with a wall thickness of not less than 3 mm (1/8") and a length of not less than one and a half times the diameter of the mounting stud. (see Diagram 6.6)

6.62.1(a)

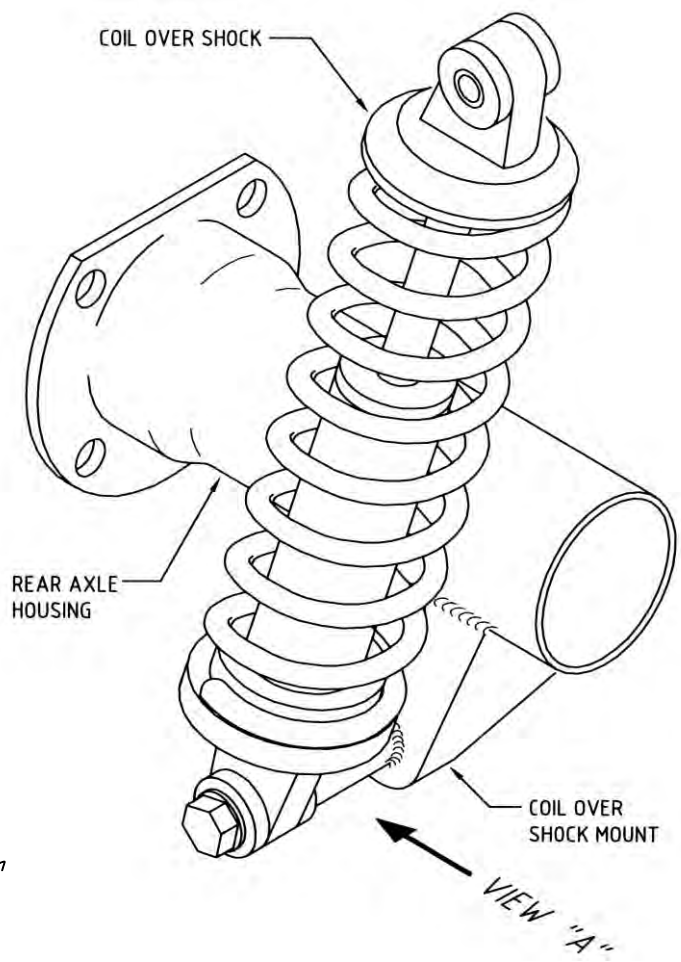
'Double-shear' means an attachment method that supports the component on both sides, rather than the cantilevered effect achieved by a single-shear attachment system.

6.62.1(b)(iv)

See Diagram 6.6 for single-shear mounting details.

6.62.2

A coil spring fitted to a low volume vehicle must be of a sufficient rate so as not to be able to fully compress upon full suspension travel.



GW diagram

GW diagram

Diagram 6.6 Single-shear coil-over shock absorber attachment

6.63 Heavy-duty and height-changing coil springs

6.63.1

A low volume vehicle fitted with coil springs must:

(a) *be fitted with shock absorbers which are able to satisfactorily control spring energy; and*

(b) *where a substantial increase in spring rate occurs, be reinforced as necessary in the areas of the body or chassis or sub-frame structure on which the increased loads being transmitted are likely to cause fracturing or failure.*

6.63.2

Coil springs fitted to a low volume vehicle that reduce the suspension travel and, as a result, the ride height of the vehicle, must be proportionately increased in stiffness rate so as to ensure against contact between the underside of the vehicle and the road surface during normal vehicle operation when fully laden.

6.63.3

Coil springs fitted to a low volume vehicle must be designed in such a way that the ends of the springs, whether of a plain, plain and ground, closed, or closed and ground configuration, are shaped to match the surfaces against which they seat, both top and bottom.

6.63.4

Progressive-rate coil springs fitted to a low volume vehicle must have the closely-wound section of the coil positioned either:

(a) *at the end nearest the body, chassis, or sub-frame structure; or*

(b) *in accordance with the spring or vehicle manufacturer's specifications.*

6.64 Coil spring containment

6.64.1

Coil springs fitted to a low volume vehicle must be firmly contained within their locating seats in such a way that the springs can not rotate, move vertically, or become dislodged when the suspension travel reaches its maximum rebound, limited by either:

6.64.1

A dislodged spring can have a substantial effect on a vehicle's handling, and a lost spring can multiply this effect further, as well as potentially puncturing a tyre sidewall.

An acceptable method of containing a coil is suitably strong hooked clips that attach to the suspension arm or strut by welding or bolting, that clamp around the spring. 'Keeper' springs are a common method of tensioning the spring in an adjustable platform suspension system.

(a) *a shock absorber of a compatible stroke length; or*

(b) *properly fastened retaining clamps; or*

(c) *properly fastened wire-rope straps of the type used in motor-sport applications, provided that the suspension mounting points are sufficiently strong to withstand the increased loadings imposed by the straps reaching the end of their travel, particularly in the case of MacPherson-strut suspension systems.*

6.65 Coil spring modifications

6.65.1

Coil springs fitted to a low volume vehicle must not be modified for the purpose of changing the vehicle's ride height unless either:

(a) *the spring is modified by a recognised spring manufacturer, and the configuration of the modified spring ends match the end configuration of the original spring; or*

(b) *the spring:*

(i) *fitted to the vehicle in its original configuration had plain unground ends; and*

(ii) *no heat is used during the modification process.*

6.65.2

Coil springs fitted to a low volume vehicle may be electro-plated provided that:

(a) the springs have not been previously electro-plated; and

(b) the springs are in good condition and require minimal time in the cleaning bath to prepare them; and

(c) the electroplating is carried out by a reputable electroplating company with experience in relieving hydrogen entrapment; and

(d) documented evidence is provided to substantiate that the springs have undergone an appropriate post-plating heat treatment process to avoid hydrogen embrittlement from the springs.

6.65.2

Reputable aftermarket electroplated springs (such as QA1 etc) may be used in their as-manufactured state.

6.65.2(d)

'Baking' at 200 degrees Celsius for 4 hours immediately after the plating process is the recommended procedure that is considered necessary to remove any hydrogen entrapment that is likely to occur (subsequently causing 'hydrogen embrittlement') as a result of the electroplating process.

6.66 Leaf spring modifications

6.66.1

A low volume vehicle must not be lowered by the fitting of a leaf spring mounted in the upside-down position.

6.66.2

The spring eyes of a leaf spring fitted to a low volume vehicle may be reversed, provided that the process is carried out by a recognised industry expert, professionally engaged in the manufacturing and modification of springs.

6.66.3

A dead-perch used to locate a front axle on a low volume vehicle must be positioned on the side of the vehicle opposite to the steering box.

6.66.4

A leaf spring fitted to a low volume vehicle may only be manufactured or modified by a recognised industry expert, professionally engaged in the manufacturing and modification of springs.

6.67 Leaf spring hanger systems

6.67.1

Spring shackles fitted to a low volume vehicle, if longer than 150 mm (6") between shackle pin centres, must be reinforced to prevent bending under cornering loadings.

6.68 Leaf spring height adjustment blocks

6.68.1

Spacer blocks which have been fitted to a leaf spring suspension system in a low volume vehicle, to raise or lower the ride height of the vehicle, must be of a depth no greater than:

(a) *50 mm (2") if not supported by lift-bars or anti-tramp rods; or*

(b) *if supported by correctly fitted and adjusted lift-bars or anti-tramp rods, 80 mm (3 5/32").*

6.68.2

A spacer block fitted to a leaf spring suspension system to raise or lower the ride-height of a low volume vehicle must be positively located at the top and the bottom of the block.

6.66.2

'Reversing' eyes is the process of changing the spring shackle mounting eye from one side of the spring surface to the other. This is a common method of lowering.

6.66.3

A dead-perch is a system by which one side of a transverse leaf spring is locked to prevent any lateral movement.

6.66.4

This does not include the removal or refitting of one or more leaves within a leaf spring.

6.69 Spring attachment points

6.69.1

The front or rear weight of a low volume vehicle must be supported through the vehicle's springing system, directly onto the front and rear axles, and not to the vehicle's longitudinal location links, unless the longitudinal location links and associated bushings are designed to withstand the vehicle's spring loads.

6.69.1

In all cases, the spring load should be applied as closely as possible over the axle (front and rear) centerline as possible, rather than applying spring load part way along the radius rods. Radius loads are usually designed to locate an axle, not to support or be subjected to spring loads.

A 'suicide front end' arrangement (where a transverse leaf spring is positioned behind the axle) is an exception to the above rule, and can work on OE radius rods, but not on hairpin radius rods.

6.70 Shock absorbers

6.70.1

A low volume vehicle must have a method of effective road shock dampening for each wheel.

6.70.2

A shock-absorber fitted to a low volume vehicle must be compatible in stroke and rate to the spring with which it operates.

6.71 Suspension travel

6.71.1

A suspension system incorporated within a low volume vehicle may be modified to raise or lower the ride-height of a vehicle, provided that:

(a) any lever-actuated brake bias control, if fitted, is repositioned if necessary in order to maintain correct operation; and

(b) no binding of any suspension or steering joints can occur as a result of the changes in suspension geometry; and

(c) bump-steer geometry is not increased beyond that which would be expected at the original suspension height; and

(d) drive-shaft universal angularity does not exceed the maximum operating angles specified by the drive-shaft universal manufacturer; and

(e) sufficient drive-shaft yoke engagement remains throughout all extremes of suspension travel; and

(f) in the case of vehicles originally fitted with a front torque control rod positioned from the top of the diff housing forward to the chassis:

(i) the torque rod is retained; and

(ii) the torque rod is lengthened or shortened as necessary in order to maintain correct suspension geometry throughout the full range of suspension travel.

6.71.2

Suspension travel available within a low volume vehicle must be such that:

(a) *no interference is likely to occur between the underside of the body and any drive-shafts or other drive-line components during full suspension movement; and*

(b) *full suspension compression is unlikely to be reached during normal vehicle operation on smooth road surfaces when fully laden.*

6.71.3

Tyres and wheel-rims fitted to a low volume vehicle must be positioned in such a way that they cannot contact any part of the vehicle to which they are fitted, other than the point of attachment, throughout the full range of steering and suspension movement during normal vehicle operation.

6.72 Bump-stops

6.72.1

A low volume vehicle must be fitted with purpose-designed bump-stops that:

(a) *are undamaged, and are not excessively worn; and*

(b) *are positioned to provide sufficient clearance from any suspension components so as to allow suspension travel suitable for the safe operation of the vehicle when fully laden; and*

(c) *limit the suspension travel before the ball-joints have reached the end of their effective travel; and*

(d) *function effectively to ensure that suspension or body components are cushioned from the transfer of excessive shock loading at the limit of suspension travel.*

6.72.1

This is to avoid shock load damage upon bottoming out under full suspension compression. A rubber donut type buffer stop is acceptable, and can be incorporated into coil-over shock absorbers that do not have one already fitted.

6.73 Suspension system component attachment

6.73.1

All fasteners incorporated in suspension system attachment, modification, or adaptation within a low volume vehicle, must meet all requirements specified from 18.2 to 18.6 inclusive in 'Chapter 18 - Attachment Systems'.

6.74 Welding of suspension components

6.74.1

All welding incorporated in suspension system attachment, modification, or adaptation within a low volume vehicle, not specifically covered elsewhere within this chapter, must meet all welding requirements specified in 'Chapter 18 - Attachment Systems'.

6.74.1

See the 'Useful Information' section at the end of this chapter for information on welding castings and forgings.

Welding carried out on a vehicle built before 1992 is not required to comply with 6.74.1, provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

Exclusions

No exclusions apply to this chapter.

Useful information

After-market suspension components

Be careful not to fall into the trap of thinking 'because it's made in the USA or UK it'll be good'... This is not necessarily so. There have been several instances of 'big brand-name' components being looked at here in NZ and consigned to the junk-pile because of their sub-standard design and/or construction methods. In many cases, the typical clever Kiwi car builder can do a much better job than some of the big overseas brand names.

Any after-market component still has to meet the same basic good engineering principles and procedures as the ones you build yourself.

Unless the component has been individually approved in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc), it still has to meet all the requirements of 'Chapter 6 - Suspension Systems'.

Shock absorber positioning

When planning your shock positioning, there are two main points to remember (this applies to both coil-over shocks and shock absorbers on their own).

Firstly, keep the mounting points as far apart (as close to the wheels) as reasonably possible. This is essential for general stability.

Secondly, keep the shocks near vertical, with ideally, 10-15 degrees of 'lean-in' at the top. This means that, when the vehicle is viewed from the front or the rear, the top end of the shock should be positioned inward toward the center of the vehicle by 10-15 degrees. By doing this, the shock approximately follows the arc prescribed by the suspension system. If there is too much inward angle, the piston rod travel will be reduced, which affects the preciseness of the shock's damping control.

Custom independent front suspension adjustment

Although not a requirement, by far the best method of providing caster and camber adjustment in custom independent front suspension top or bottom a-arms is through the use of eccentric bushings or shimming.

The simpler screw-in/out rod ends are not recommended as this system introduces the risk of stress on the threaded sections, pivot axis misalignment due to unequal adjustment of rod ends, and inadequate thread engagement into the suspension arms.

If the screw-in/out rod end system is used, the one-and-a-half diameter-depth inspection hole should be provided as shown in Diagram 6.5.

Custom independent front suspension A-arm material specifications

Table 6.1 on page 6-9 provides the minimum required material specifications for the manufacture of custom IFS A-arms, based on vast practical experience gained from established New Zealand car builders, together with other real-life knowledge accumulated from other parts of the world.

There are two situations where the specifications provided in Table 6.1 may be deviated from:

- In the case of a typical very lightweight Lotus 7 style sports car (assuming normal arm length and spring load mounting positions), the TAC will allow 19 x 1.5 mm (instead of the specified 22 x 1.6 mm) for the top arms, and 22 x 2.5 mm (instead of the specified 25 x 2.0 mm) for the lower arms.

  These specifications are allowed because of these sizes being successfully employed by overseas sports car manufacturers. Note however that (in theory at least) these specifications are considered borderline and allow very little margin for error, so the TAC would recommend staying with the specifications provided in Table 6.1.

- Table 6.1 assumes that the IFS is a standard design which applies the spring load to the lower suspension arm. Where an IFS shifts away from this 'standard' design and applies the spring load to the top arm instead of the bottom arm (such as where an inboard rocker arm system is used), the A-arm specifications for upper arms and lower arms should be applied conversely.

Note however, that the lower arm must never be reduced below that specified in the table, irrespective of whether or not the lower arm is loaded.

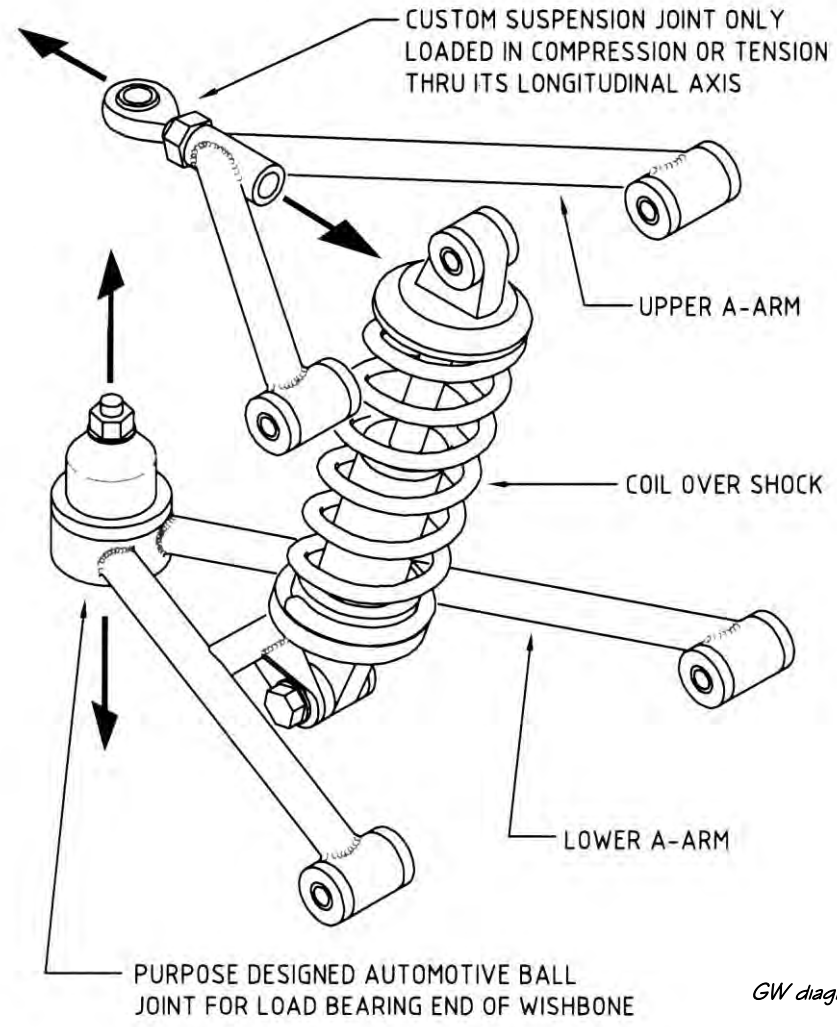
Inspection holes on radius rods

It is important that sufficient thread engagement of a rod end into a suspension radius rod must be visible (after wheel alignment has occurred). Although the LVV Certifier may accept the thread engagement on the basis of what is visible, and the fact that a quality end is used, an inspection hole of one-and-a-half diameter depth (of the radius rod material) in is still the ideal method of ensuring the rod end is properly engaged. (see Diagram 6.5)

Loaded suspension joints

In front suspension systems, it is important to ensure that the suspension joint that supports the vehicle weight – usually the lower outer joint – is in fact a proper automotive ball-joint designed for axial-loading. Typical spherical rod ends and tie-rod ends are not designed to support vehicle weight – they are designed for compression and tension loadings. Although the lower outer suspension joint is generally the axial-loaded joint, note that the upper joint becomes the loaded joint in the case of an inboard rocker-arm type suspension system. They also wear faster than a proper automotive load-carrying ball-joint will.

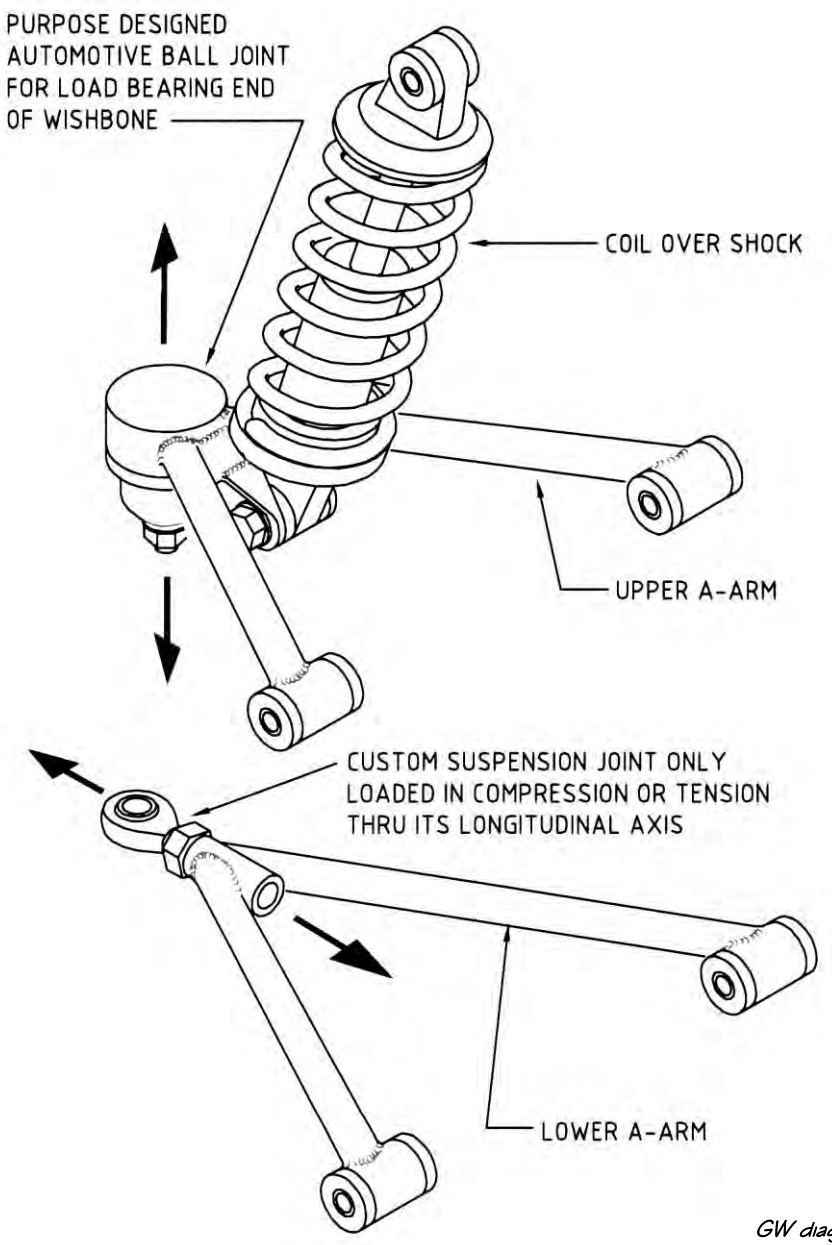
Although the (non-load bearing) joints in a front suspension should also be proper automotive ball-joints, in the case of very light sports cars, it is possible to get away with using premium quality spherical bearing rod ends, or tie-rod ends. The requirement for an upper ball-joint does not apply to typical non-load bearing situations such as the top pivot/camber adjustment plate on a McPherson strut assembly.



GW diagram

The illustration above shows a common type of independent front suspension configuration, which carries the load-path, or vehicle weight, at the outer end of the bottom wishbone. In this situation, the bottom wishbone must use a proper automotive ball-joint, and in the case of a very light-weight sports car, it would be acceptable to use a premium quality spherical rod end or tie-rod end.

Loaded suspension joints (continued)



GW diagram

The illustration above shows a less-common type of independent front suspension configuration, which carries the load-path, or vehicle weight, at the outer end of the upper wishbone. This system is often found in race cars (with the coil-over shock swung around and aimed downward) and is referred to as inboard rocker systems.

In this situation, the upper wishbone must use a proper automotive ball-joint, and again, in the case of a very light-weight sports car, it would be acceptable to use a premium quality spherical rod end or tie-rod end.

Jaguar independent rear suspension systems

One of the more common mistakes hot rodders and sports car builders made in the early days was to mess up the geometry when mounting an early Jaguar IRS into their hobby car.

If using a Jaguar IRS, and taking it out of its (hardly pretty) cage, care needs to be taken to ensure that the front mounting points of the radius rods are positioned in such a way that there is no binding as the IRS goes through its travel from full extension to full droop. Any minor misalignment can be dealt with by incorporating very large and soft rubber bushes, similar to that used by Jaguar in the IRS's original application.

More information will be available on this subject via an LVVTA (Inc) Information Sheet, which will be on the LVVTA website when completed. There are many theories surrounding the correct geometry in an early Jaguar IRS, and this will be fully explained, with some popular old mythology clarified within the Information Sheet.

Beam axles

Don't jack the front of a vehicle fitted with a production I-beam axle in the center of the beam. Old Ford I-beams are made from a very soft malleable iron, and can bend when jacked up in the center. (This same 'weakness' is what allows a split radius rod system or hairpin radius rod to work ok with a Ford I-beam)

Welding of castings and forgings

A basic but very important engineering principle, emphasised throughout the whole LVV certification process in New Zealand, is that a forging or casting in a critical situation like suspension, steering, or brakes, must not be heated and bent, or welded, except in highly controlled circumstances.

A forging or casting that is heated during a welding process must be re-heat treated afterwards, and this cannot be done correctly unless the exact molecular structure of the forging or casting material has been properly established beforehand by a metallurgist – which in turn enables the appropriate heat-treatment method to be established. This process is costly, and not practicable in one-off situations.

There is a very real risk of changes occurring within the molecular structure of a steel forging or casting when a welding process is applied, particularly if too much heat is applied during the heating or welding process, and the problems that this can create are often irreversible.

If anyone has a legitimate need to do this, it may be allowed, but only after having received written approval from the Technical Advisory Committee on a case-by-case basis.

The old practice of heating and bending, or welding, forgings or castings is for the history books; better components and machining processes are available now, to the extent that these practices can be left behind in the 'good old days' forever!

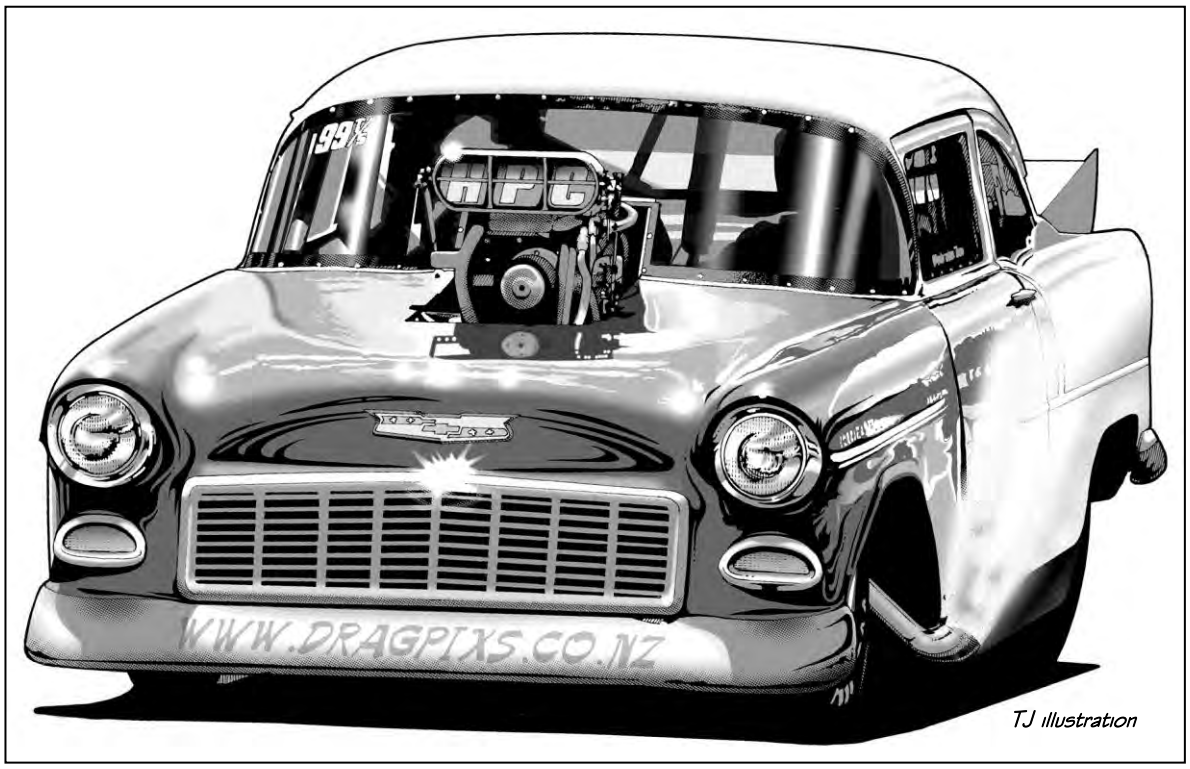
Old stub axles

Exercise caution when using old stub axles, particularly old Ford V8 items. These are often cracked and should be non-destructive tested (NDT'd – in this case crack-tested) before being used. The axles often have surface cracks or defects at the point where the steering arm joins the main body of the forging, which can often be polished out to prevent the minor surface defects continuing to become dangerous defects.

Good books on suspension

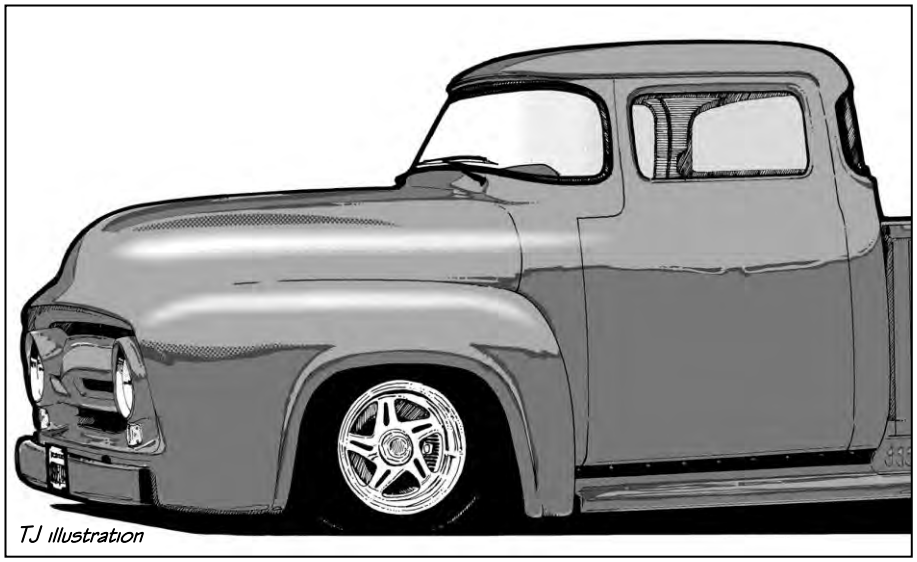
The following books provide some excellent advice on designing, fabricating, installing, and setting performance-orientated suspension systems, and are recommended by the Technical Advisory Committee:

- 'Engineer to Win' by Carrol Smith
- 'Tune to Win' by Carrol Smith
- 'Race Car Fabrication and Preparation' by Steve Smith Autosports
- 'Advanced Race Car Suspension Development' by Steve Smith Autosports
- 'Fundamentals of Motor Vehicle Technology' by V.A.W. Hillier and F Pittuck



Chapter 7:

STEERING SYSTEMS



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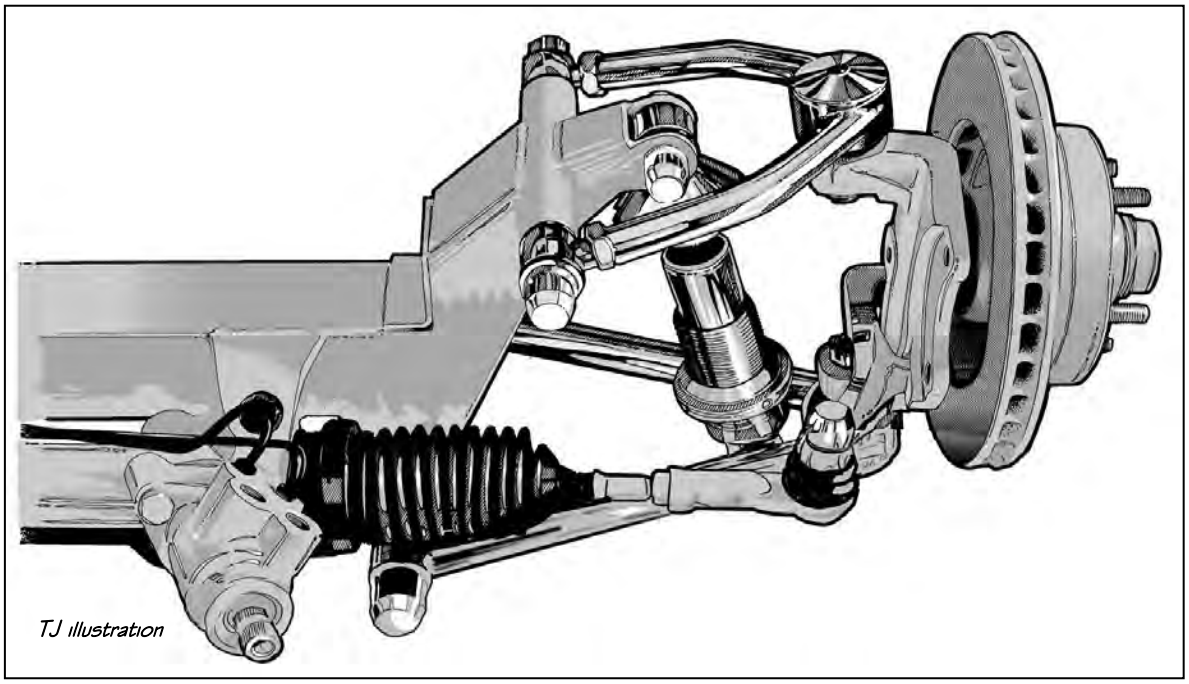
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Key: (for full key details, refer to 'Chapter 2 – About this Manual')

Normal type: Provisions of the NZ Car Construction Manual for all vehicles
Normal type in shaded box: Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates
Italic type: *Extracts from any relevant LVVTA Low Volume Vehicle Standards*
Script type: Helpful hints, tips, explanations, clarifications, and interpretations
Shaded text & dotted vertical stroke in margin: Latest amendments since previous version



TJ illustration

CHAPTER 7: STEERING SYSTEMS

Introduction:

Steering component selection, compatibility, geometry, and attachment is undoubtedly the single-most important aspect of any hobby car's design and construction. In this area, there can be no compromises. Aside from the obvious safety aspect, a well-designed steering system can make the difference between a vehicle that is, or isn't, a pleasure to drive and ride in, and compared to other parts of a hobby car, the steering system doesn't represent a big part of the overall cost. You'll never regret spending a bit of extra money or getting the right advice in this area.

In addition, this chapter sets out requirements to minimise crushing or penetrating injuries to the driver from the steering wheel and upper column in the event of a frontal impact. Note that where a production vehicle is fitted with its original unmodified steering system, the requirements in this chapter do not apply.

Steering wheel requirements:

7.1 All steering wheels

7.1.1

A steering wheel fitted to a low volume vehicle must:

(a) incorporate a continuous 360-degree steering wheel rim; and

(b) be predominantly circular in shape; and

7.1.1(b)

'Predominantly circular' allows the use of aftermarket racing-style steering wheels that have a flat bottom section.

(c) attach to a steering hub or boss that is compatible with the upper section of the steering column; and

(d) incorporate, in order to secure the steering wheel against the steering wheel hub or boss, a fastener that either:

(i) is supplied by the steering wheel manufacturer specifically for that purpose; or

(ii) is of a vibration-proof type.

7.1.2

A steering wheel that is fitted to a low volume vehicle must be of a diameter that is:

(a) not less than 245 mm (10”); and

(b) large enough in diameter to enable the vehicle to be safely steered, taking into consideration:

(i) the weight of the vehicle; and

(ii) the number of turns required to turn the vehicle from lock to lock.

7.1.3

A steering wheel that is fitted to a low volume vehicle must have no surfaces, fittings, or projections that may cause additional injury to the driver in the event of contact during an impact.

7.2 Airbag-equipped steering wheels

7.2.1

A steering wheel that incorporates a supplementary restraint system airbag that is fitted to a modified production low volume vehicle, may not be replaced by any steering wheel other than a direct factory replacement, unless either:

(a) the vehicle:

(i) is 14 years old or older; and

(ii) meets the requirements of LVVTA Low Volume Vehicle Standard 155-30 (Frontal Impact);

or

(b) the vehicle is issued with a valid LVV Authority Card, which specifies ‘Frontal impact protection system’.

7.3 After-market & non-original production steering wheels

7.3.1

A steering wheel fitted to a low volume vehicle must, other than one specified in 7.4, be either:

(a) sourced from a mass-produced vehicle; or

(b) manufactured by an after-market steering wheel manufacturer.

7.3.1(b)

Some older aftermarket steering wheels are attached to the steering hub with rivets. These wheels should not be used, as there have been several known cases where the rivets have failed.

7.3.2

A steering wheel that is manufactured by an after-market steering wheel manufacturer must either:

(a) be manufactured predominantly from aluminium; or

(b) in the case of a steering wheel manufactured from a material with more impact resistance than aluminium, be designed so as to absorb impact energy by deforming away from the upper torso in the event of contact during an impact.

7.3.2(b)

This precludes 'chain-link' steering wheels, or other wheels constructed from large non-deformable sections of material like mild steel.

7.4 Individually-constructed steering wheels

7.4.1

A steering wheel that is individually-constructed, and fitted to a low volume vehicle, must be individually approved in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc).

7.4.1

'Individually constructed' means built as a one-off by someone who is not professionally engaged in the steering wheel manufacturing industry.

7.5 Quick-release steering wheels

7.5.1

A steering wheel fitted to a low volume vehicle that is able to be removed and re-attached without the use of tools to assist entry and exit to and from the vehicle, must:

(a) self-lock into position, with no separate devices or non-integral parts of the system required to lock the wheel into its locked position; and

(b) not be able to be removed without a deliberate and firm action applied in order to achieve the removal.

7.5.1

Quick-release wheels are not recommended for road use, and should only be used where the design of the vehicle makes a quick-release steering wheel necessary for easing entry and exit.

7.6 Steering wheel hubs

7.6.1

A steering wheel hub or boss fitted to a low volume vehicle must attach to an upper section of steering column that incorporates sufficient spline depth to provide for the fitment of the hub and a vibration-proof fastener.

Steering column requirements:

7.7 Steering column positioning

7.7.1

A steering column fitted to a low volume vehicle must be located so as to enable the rim face of the steering wheel to be positioned at an angle of not less than 30 degrees from the horizontal plane. (see Diagram 7.1)

7.7.1

Vertical columns must not be fitted to newly constructed vehicles, or where a new steering system is fitted to an existing vehicle, as a vertical or near-vertical column does not enable optimum steering control.

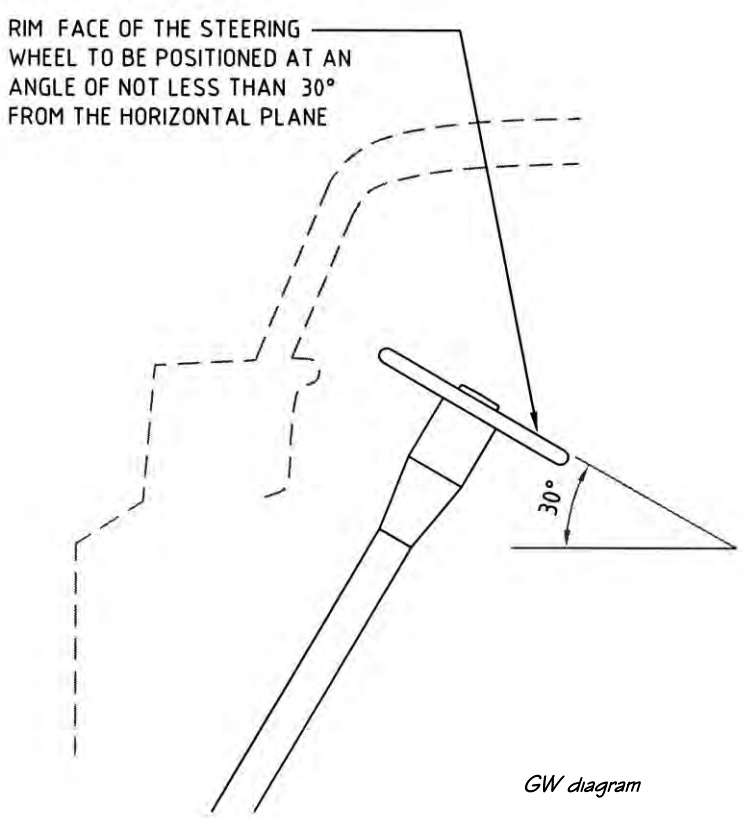


Diagram 7.1 Steering column positioning

A low volume vehicle that was built, or was fitted with a vertical steering column prior to 1992, is not required to comply with 7.7.1, and may remain in use, provided that:

(a) the rack and pinion assembly is positioned so that its angle, when viewed from both above and side-on, is within 10 degrees of parallel to the drag-link, with the wheels facing directly forward; and

(b) the vehicle can be easily steered, with no more than two and a half turns of the steering wheel required to turn the system from lock to lock.

7.7.1 (b)

1.5 turns lock to lock is considered ideal for a light-weight vehicle with a vertical steering column.

7.7.2

A steering column fitted to a low volume vehicle must not be positioned between the brake pedal and the accelerator pedal.

A low volume vehicle that was built, or was fitted with a new or changed steering system before 1992, which incorporates a steering column between the brake and accelerator pedals, is not required to comply with 7.7.2

7.8 Steering column modification & attachment

7.8.1

A steering column fitted to a low volume vehicle must be adequately supported at both the upper and lower ends of the column, to ensure that the column remains secure throughout all normal vehicle operation.

7.8.2

No safety-critical part of a steering column may be welded, unless the welded section is the vehicle manufacturer's unmodified original equipment.

7.8.2

A steering column fitted to a low volume vehicle must not have any part, other than an outer housing which is not relied upon for the directional control of the vehicle, welded, unless the welded section is the vehicle manufacturer's unmodified original equipment.

7.9.1

Unless a vehicle manufacturer's original equipment operating in the same application for which it was originally designed, a universal that attaches by way of a hexagon, square, keyway, or cotter pin, is to be considered an industrial or agricultural unit, and not automotive, and therefore must not be used in any hobby car application.

Steering universal joint, coupling, & intermediate shaft requirements:

7.9 Steering universal joints

7.9.1

A change of direction between a steering column, and a rack and pinion or box, in a low volume vehicle, must only be effected by steering universal joints, which:

(a) are purpose-designed universal joints for automotive applications, manufactured by a recognised automotive universal manufacturer; and

(b) except in the case of a universal joint that is a production vehicle manufacturer's original equipment:

(i) are accompanied by written specifications and application information, provided by the manufacturer of the universal joint; and

(ii) incorporate an attachment cross-pin that operates on needle rollers or bearings.

7.9.1 (b)(ii)

Some vehicles such as XJ6 Jaguar have an OE hard steel bush and pin assembly, which is acceptable, as they incorporate a sintered bronze bush, unlike some steel-on-steel aftermarket or industrial units.

7.9.2

A universal joint incorporated within a steering system in a low volume vehicle must not exceed:

(a) the amount of angularity specified by the universal joint manufacturer; or

(b) if the universal joint manufacturer's specifications are not available, 30 degrees.

7.9.3

Where more than one steering universal joint is incorporated within a steering system in a low volume vehicle, the universal joints must be correctly phased for the application, which will be somewhere between the two positions shown in Diagram 7.2, depending on angularity between the two universals. (see Diagram 7.2)

7.9.3

'Correct for the application' will vary depending on the amount of angularity of the intermediate shaft between the first and second universal. If the angularity between the two is similar, the phasing shown in the top diagram will be close to correct. Some minor phasing adjustment maybe required after installation. For this reason alone, a splined universal on at least one end is essential.

Often, when this is wrong, 'notchiness' is experienced at certain points of the steering lock.

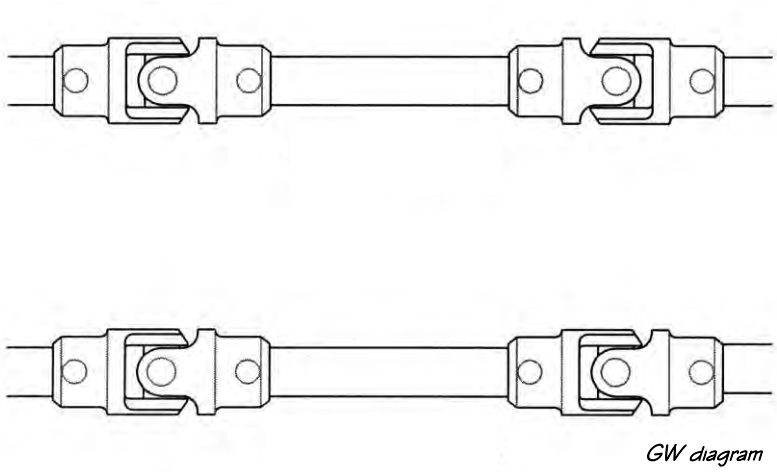


Diagram 7.2 Universal joint phasing

7.9.4

A steering universal joint incorporated within a steering system in a low volume vehicle must either be:

(a) positioned with adequate clearance from the exhaust system; or

(b) provided with a shield to protect the universal from excessive heat from the exhaust system.

7.9.4

An acceptable distance from the exhaust system for a steel universal is generally considered to be 25 mm (1").

7.10 Flexible steering couplings

7.10.1

In the case of a vehicle that has a flexible mounting system that allows the body to move independently from the chassis, some form of flexible steering coupling must be incorporated within the steering system, to prevent the system from being loaded during body movement on the chassis.

7.10.1

This applies mostly to off-road vehicles that use large flexible block-type mounts to isolate vibration and shock, rather than the strips of rubber typically used in old passenger vehicles.

7.10.2

A flexible steering coupling fitted within a steering system in a low volume vehicle must;

(a) be in good condition; and

(b) contain no more attachment holes than required for the application in which it is being used; and

(c) incorporate minimal end-load against the coupling; and

(d) have either:

(i) no misalignment; or

(ii) a maximum of 5 degrees of misalignment if the coupling is used in a situation that duplicates its original set up in the production vehicle from which the coupling was sourced.

7.10.2

A flexible steering coupling is otherwise known as a 'fabric damper' or a 'rag coupling'.

A flexible steering coupling includes modern replacement urethane items.

7.10.3

A flexible steering coupling fitted within a steering system in a low volume vehicle must either:

(a) be positioned with adequate clearance from the exhaust system; or

(b) be provided with a shield to protect the flexible coupling from excessive heat from the exhaust system.

7.10.3

An acceptable distance from the exhaust system for a flexible coupling is generally considered to be 50 mm (2"), and the distance for modern urethane materials should be more. A heat-shield is the preferred option.

7.11 Steering intermediate shafts

7.11.1

A custom-manufactured steering intermediate shaft incorporated within a steering system in a low volume vehicle, must be manufactured from a high quality, easily-machinable material that is readily available.

7.11.1

SAE 4130 is an ideal material for this application.

7.11.2

A steering intermediate shaft in a low volume vehicle, positioned between the steering rack or box, and the steering column, must, except as specified in 7.11.4, attach to the output shaft or ends of the steering rack and pinion or box, and column, with either:

(a) a correctly machined spline that is compatible with the steering universal to which it attaches; or

(b) a non-circular clamping system, that is a close tolerance fit to the universal to which it attaches; or

(c) another suitable form of retention that replicates a recognised system used in modern vehicle construction by a mass-production vehicle manufacturer.

7.11.2(b)

This can be a common 'double-d' or triangular system typically found in production vehicles.

7.11.2(c)

Examples of this include a drilled and bolted system such as that used on Chevrolet pick ups, or the sliding cross-pin system used in HQ Holdens.

7.11.3

An intermediate shaft positioned between the steering rack or box and the steering column in a low volume vehicle, must incorporate, in order to ensure against the splined or clamped sections becoming loose and separating, a secondary means to keep the splined or clamped sections firmly locked together, which can be either:

(a) a clamp; or

(b) a roll-pin; or

(c) a grub-screw.

7.11.3

Some OEM steering attachment systems have only one means of attachment. An example of this is the Holden Torana and other GM systems, where the sole attachment method is a tapered cotter-pin positioned against a machined flat surface. Where such a system from a mass-produced vehicle is used, exactly as employed in its OEM application, 7.11.3 does not apply.

7.11.4

A steering intermediate shaft must not be welded, unless in the case of either:

(a) a vehicle manufacturer's unmodified original equipment operating in the same application for which it was originally designed; or

(b) a custom-manufactured or modified item, in which:

(i) the welding is carried out in accordance with the welding requirements specified in 7.41.2; and

7.11.4

A steering intermediate shaft - and for that matter any other steering component – should not be welded unless there is no other option available, and every potential risk is removed from the welding process.

(ii) individual approval in writing is obtained from the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc).

A low volume vehicle that was built, or was fitted with a welded steering intermediate shaft before January 2007, may continue to use that shaft provided that the shaft meets the requirements of 18.9 of 'Chapter 18 – Attachment Systems'.

7.11.5

Each pair of steering universal joints incorporated within a steering system in a low volume vehicle must be supported by either:

(a) a suitable self-aligning bearing; or

(b) a suitable self-aligning sleeve; or

(c) a bush manufactured from a material that will maintain its shape under load.

7.11.5(c)

Teflon for example, will swell and extrude, and therefore cannot be used in this application.

Steering system collapsibility requirements:

7.12 Steering system collapsibility design

7.12.1

A low volume vehicle must incorporate a steering system that, at the front, will collapse in order to minimise rearward displacement of the upper end of the steering column, as a result of a frontal impact, and which:

(a) incorporates a securely and rigidly mounted upper column attachment and supporting structure; and

(b) ensures that the failure mode of the steering column will, in the event of a frontal impact, be by its lower collapsible system.

7.13 Methods of achieving steering system collapsibility

7.13.1

The collapsibility of a steering system in a low volume vehicle may be provided by incorporation of either:

(a) the steering box or rack and pinion mounted behind the front suspension beam; or

(b) a collapsible steering column from a mass-produced vehicle, provided that:

(i) the attachment of the steering column and associated components duplicates the installation in the vehicle to which it was originally fitted; and

(ii) the structure to which the steering column and associated components are attached has at least the same structural integrity as the corresponding areas of the vehicle to which they were originally fitted; and

(iii) the angle of any couplings between the lower end of the upper steering column and the connecting lower steering shaft does not exceed the donor vehicle or component manufacturer's specifications;

or

(c) collapsibility into the lower steering column or steering intermediate shaft, by a sliding section; or

(d) a longitudinal steering drag-link that connects the steering box to the driver's side steering arm; or

(e) collapsibility into the steering system by ensuring that an angle of not less than 10 degrees is intentionally designed into the system, between the lower end of the steering column, and the steering box or rack and pinion. (see Diagram 7.3)

7.13.1(c)

An example of this method of collapsibility is the flat sliding shaft system used in the Holden Commodore.

7.13.1(d)

This means a typical side-steered beam axle 'push-pull' drag-link system.

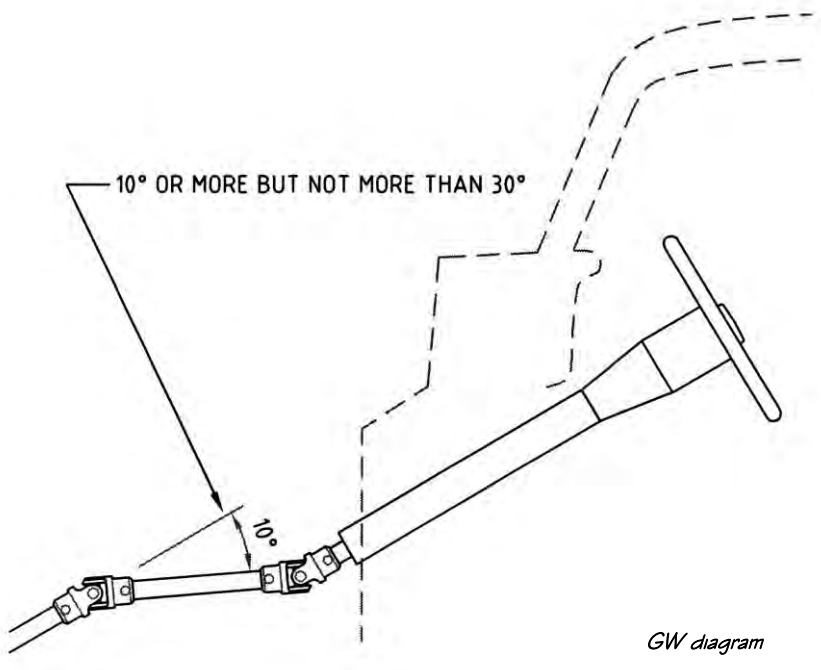


Diagram 7.3 Steering system collapsibility

7.13.2

Any steering column support, or support for a pair of steering universals within a steering system in a low volume vehicle, must be positioned and attached in such a way so as not to compromise the performance of any part of the steering system's collapsibility features.

Steering rack & pinion assembly requirements:

7.14 Steering rack and pinion suitability

7.14.1

A steering rack and pinion assembly fitted to a low volume vehicle must be:

(a) of a type designed specifically for automotive applications; and

(b) of an appropriate size and strength for the vehicle to which it is fitted, taking into consideration front axle weight.

7.14

A power rack and pinion assembly may be used in a non-power application. This often occurs in race car construction, so as to take advantage of better ratio availability.

7.15 Steering rack and pinion ratios

7.15.1

The ratio of a rack and pinion steering system in a low volume vehicle must be a compatible match, and have an appropriate feel for the type of vehicle to which it is fitted, taking into consideration:

(a) the weight of the vehicle; and

(b) the amount of travel within the suspension system.

7.15.1

A very high-ratio steering system which results in one-and-a-half turns lock to lock, for example, would not be suited to a heavy vehicle, particularly one with a lot of suspension travel.

7.15.2

A steering rack and pinion fitted to a low volume vehicle must be of a ratio that is compatible with the length of the steering arms, in order to provide a steering system that:

(a) does not require excessive force to turn; and

(b) is not so over-sensitive as to cause difficulty in maintaining directional control of the vehicle.

7.16 Steering rack and pinion assembly attachment

7.16.1

A steering rack and pinion assembly fitted to a low volume vehicle must be mounted to the vehicle structure:

(a) using the same type of mounting method, and with no less strength and rigidity than that provided by the manufacturer of the vehicle to which the rack and pinion assembly was originally fitted; and

(b) with the attachment points as far apart as practicable to reduce leverage on the rack and pinion assembly housing during turning loads; and

(c) in such a way that the rack and pinion assembly cannot move transversely within its mounting position.

7.16.1(c)

The mounting system of a rack and pinion must feature some form of machined shoulder to 'register' the clamping system, so as to properly locate the rack and prevent against sideways movement.

This does not preclude the use of cushioning mounts, providing that the mounts are properly locked.

7.16.2

A steering rack and pinion assembly fitted to a low volume vehicle must be attached using:

(a) all of the fastening points incorporated within the steering rack and pinion assembly housing by the vehicle manufacturer; and

(b) fasteners of equal or greater size and strength as originally used by the vehicle manufacturer.

7.16.3

A steering rack and pinion assembly fitted to a low volume vehicle must be positioned equidistantly, enabling the steering rack ends to be the same length to the steering arm pivots on each side.

7.16.4

A steering rack and pinion assembly fitted to a low volume vehicle must be mounted, wherever practicable, in a double-shear method of attachment.

7.16.4

The recommendation for double-shear mounting is especially important when the rack is mounted to a light-gauge cross-member.

7.17 Steering rack and pinion assembly modification

7.17.1

The housing of a rack and pinion assembly fitted to a low volume vehicle may be shortened provided that:

(a) the housing is joined so as to maintain correct alignment of the rack and pinion housing bushes; and

7.17

No part of a steering rack and pinion assembly, other than the housing, may incorporate welds, unless the welded section is the vehicle manufacturer's unmodified original equipment.

(b) any welding involved in the shortening process is in accordance with the welding requirements specified in 7.41.2.

7.17.2

The internal components within a manual rack and pinion steering assembly fitted to a low volume vehicle may be shortened, provided that the shortening process occurs only to either:

(a) the parts of the rack shaft to the outside of the teeth, in which case the cut end must replicate the original end before it was shortened; or

(b) the rack ends, which must be correctly re-threaded.

7.17.3

The only internal components within a power rack and pinion steering assembly fitted to a low volume vehicle that may be shortened are the rack ends, which must be correctly re-threaded.

7.17.4

The internal components within a rack and pinion steering assembly fitted to a low volume vehicle must not incorporate any welding.

7.18 Steering rack and pinion assemblies with beam axles

7.18.1

A rack and pinion steering system must not be fitted directly onto a tubular beam or I-beam front axle in a low volume vehicle.

7.18.2

This is because the independent arcs of the tie-rods, during suspension travel of the tubular or I-beam axle, will create a toe-in/toe-out bump-steer situation.

7.18.2

A rack and pinion steering system must not be positioned transversely on a low volume vehicle fitted with a tubular beam or I-beam front axle.

7.18.3

A low volume vehicle fitted with a tubular beam or I-beam front axle may incorporate a rack and pinion steering system positioned longitudinally, operating on the driver's side steering arm in the push-pull style, provided that:

(a) the rack and pinion assembly is from a production vehicle with a substantially heavier front axle weight than the vehicle to which it is fitted; and

(b) the angle of the rack end is minimised in order to prevent the rack and pinion assembly from being subjected to loadings which it was not designed for.

Steering box assembly requirements:

7.19 Steering box suitability

7.19.1

A steering box fitted to a low volume vehicle must be:

(a) of a type designed specifically for automotive applications; and

(b) of an appropriate size and strength for the vehicle to which it is fitted, taking into consideration front axle weight.

7.20 Steering box ratios

7.20.1

The ratio of a steering box in a low volume vehicle must be a compatible match, and have an appropriate feel for the type of vehicle to which it is fitted, taking into consideration:

(a) the weight of the vehicle; and

(b) the amount of travel within the suspension system.

7.20.1

A very high-ratio steering system which results in one-and-a-half turns lock to lock, for example, would not be suited to a heavy vehicle, particularly one with a lot of suspension travel.

7.20.2

A steering box fitted to a low volume vehicle must be of a ratio that is compatible with the length of the steering arms, in order to provide a steering system that:

(a) does not require excessive force to turn; and

(b) is not so over-sensitive as to cause difficulty in maintaining directional control of the vehicle.

7.21 Steering box attachment

7.21.1

A steering box fitted to a low volume vehicle must be attached using:

(a) all of the fastening points incorporated within the steering box housing by the vehicle manufacturer; and

(b) fasteners of equal or greater size and strength as originally used by the vehicle manufacturer.

7.22 Right-angle drive boxes

7.22.1

A right-angle drive box must not be used within the construction or modification of a low volume vehicle, unless its application, configuration, and attachment duplicates the way in which the right-angle drive box was used in its original mass-production vehicle application.

7.22.1

A right-angle drive box is also known as a 'bevel-box', or a 'V-drive box'. These are commonly used to effect a change in direction from the column to the rack in late-model forward-control vans and trucks.

7.22.2

A gearbox that is designed to reverse the rotation of a steering system may be used within a low volume vehicle, if the gearbox and its application has been individually approved in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc).

Steering box drop-arm & steering arm requirements:

7.23 Production steering box drop-arms

7.23.1

A steering box drop-arm sourced from a production vehicle, incorporated within a steering system in a low volume vehicle must:

(a) be from a vehicle designed for steering loads and axle weight of no less than that which would be applied by the vehicle being constructed or modified; and

(b) not be modified in any manner, including:

(i) heating; or

(ii) bending; or

(iii) welding.

7.23.1

'Production' means manufactured by a high-volume motor vehicle manufacturer.

A steering box drop-arm is also known as a 'Pitman arm'.

7.24 Custom steering box drop-arms

7.24.1

A custom-manufactured one-piece mild-steel steering box drop-arm incorporated within a steering system in a low volume vehicle may be bent to suit the needs of the application, provided that the bending process is carried out by a suitably skilled and experienced person.

7.24.2

A steering box drop-arm sourced from other than a production vehicle, except for one specified in 7.24.4, incorporated within a steering system in a low volume vehicle must be a one-piece item, without any welding involved in its manufacture, that is either:

(a) an aftermarket unit designed for automotive applications, manufactured by a recognised and reputable aftermarket steering component manufacturer; or

(b) a custom-manufactured one-piece mild-steel item.

7.24.2(b)

Such a drop-arm would typically be flame-cut or laser-cut from a sheet or bar-stock.

7.24.3

A custom-manufactured one-piece mild-steel steering box drop-arm incorporated within a steering system in a low volume vehicle must be of dimensions of not less than: (see Diagram 7.4)

(a) 20 mm (51/64″) in nominal thickness throughout the entire length of the arm; and

(b) 45 mm (1 45/64″) in total width across the steering box end of the arm; and

(c) 30 mm (1 3/16″) in total width across the drag-link end of the arm; and

(d) 8 mm (5/16″) from the outside edge of the arm to the outer edge of either opening within the arm.

A drop-arm that was fitted to a low volume vehicle before 1992 may be 16 mm (5/8″) in thickness throughout the entire length of the arm.

7.24.4

A custom-manufactured one-piece mild-steel steering box drop-arm must, in order to attach to the steering box, be bored out and either: (see Diagram 7.4)

(a) have a tapered spline machined into the drop-arm by a slotting head; or

(b) incorporate a splined section machined out of a drop-arm manufactured by a production vehicle manufacturer, that is:

(i) heat-shrunk into place; and

(ii) welded in accordance with the requirements specified in 7.41.2.

7.24.4

A slotting head is a reciprocating attachment for a milling machine that enables a tapered spline to be cut. This is approximately twice the cost of the process described in 7.24.4(b). However, the machined tapered-spline is a vastly superior process, and is by far the recommended option.

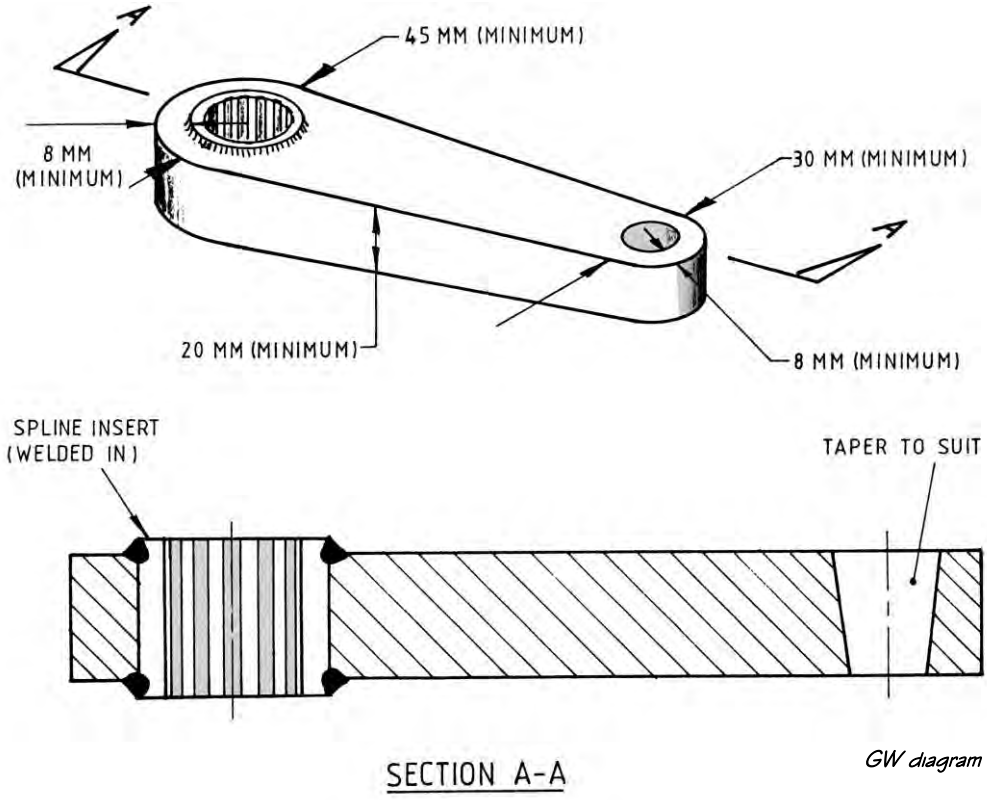


Diagram 7.4 Custom-manufactured steering box drop-arm specification

7.25 Production steering arms

7.25.1

A steering arm sourced from a production vehicle, incorporated within a steering system in a low volume vehicle, must:

(a) be from a vehicle designed for steering loads and axle weight of no less than that which would be applied by the vehicle being constructed or modified; and

(b) not be modified in any manner, including:

(i) heating; or

(ii) bending; or

(iii) welding.

7.26 Custom steering arms

7.26.1

A steering arm sourced from other than a high volume vehicle, incorporated within a steering system in a low volume vehicle must be either:

(a) an aftermarket item designed for automotive applications, manufactured by a recognised and reputable aftermarket steering component manufacturer; or

(b) a custom-manufactured mild-steel unit, that meets the requirements specified in 7.26.2.

7.26.1 (a)

Be wary of anything other than mainstream brands – the Technical Advisory Committee has seen some big-name branded components from overseas that are not suitable for road use due to their poor design.

7.26.1 (b)

These can always be successfully made as one-piece items without an over-tight radius, even in a tight-fit situation such as where a steering arm bolts to a stub axle attached to a dropped tube axle.

7.26.2

A custom-manufactured steering arm incorporated within a steering system in a low volume vehicle must:

(a) in the case of a one-piece item without any welding involved in its manufacture (see Diagram 7.5):

(i) be manufactured from a single piece of mild steel bar material, not less than 16 mm (5/8") in thickness; and

(ii) incorporate a correctly machined radius at any points where the section thickness changes; and

(iii) incorporate an internal thread for the attachment of the steering arm to the stub axle;

or

(b) in the case of an item that incorporates welding within its manufacture:

(i) be manufactured from a single piece of mild steel solid rod material, not less than 18 mm (3/4") in diameter; and

(ii) incorporate a fully-welded boss for the tie-rod end that is carried out in accordance with the requirements for welding specified in 7.41.2; and

(iii) incorporate an internal thread for the attachment of the steering arm to the stub axle.

7.26.2(a)

In the case of extreme situations where vehicle weight is substantially high and power steering is fitted, 16 mm (5/8") mild steel bar should be increased to 18 mm (3/4") mild steel bar.

7.26.2(a)

See Diagram 7.5.

7.26.2(b)

In the case of extreme situations where vehicle weight is substantially high and power steering is fitted, 18 mm (3/4") mild steel solid rod should be increased to 20 mm (51/64") mild steel solid rod.

A custom steering-arm that was fitted to a low volume vehicle before 1992 is not required to meet the requirements in 7.26.2(b), provided that 18.9.2 of 'Chapter 18 - Attachment Systems' is complied with.

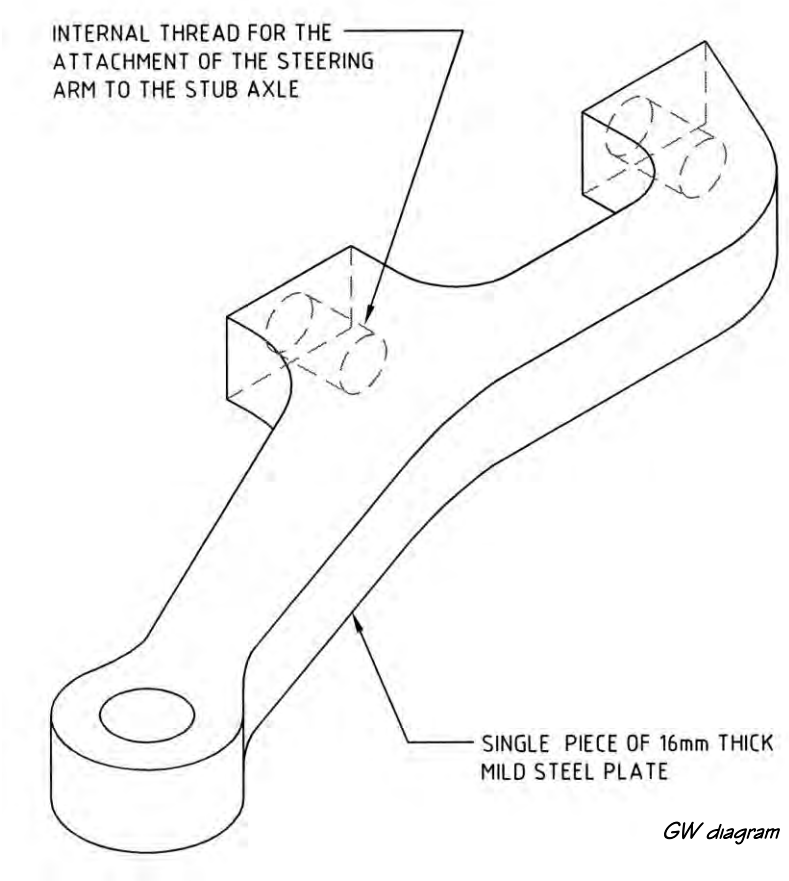


Diagram 7.5 Custom-manufactured steering arm design

Steering drag-link, tie-rod, & drag-link & tie-rod end requirements:

7.27 Steering drag-links and tie-rods

7.27.1

A custom steering drag-link or tie-rod incorporated within a steering system in a low volume vehicle must:

(a) be manufactured from a single piece of material; and

(b) attach to the drag-link or tie-rod ends by the use of threading and jamb-nut securing; and

(c) be manufactured from a material specification in accordance with Table 7.1. (see Table 7.1)

7.27.1

Where there is no alternative but to incorporate a bend within a drag-link or tie-rod, the bend must be kept to a minimum, and the material specification must be increased.

DRAG-LINK OR TIE-ROD LENGTH	MINIMUM MATERIAL SIZE
▪ Drag link or tie-rod of less than 1300 mm (51 3/16") in length	22 mm (7/8") OD x 5 mm (13/64") wall thickness mild steel tubing
▪ Drag link or tie-rod of more than 1300 mm (51 3/16") in length	25 mm (1") OD x 5 mm (13/64") wall thickness mild steel tubing

Table 7.1 Steering drag-link and tie-rod material size guide table

7.27.2

A steering drag-link or tie-rod incorporated within a steering system in a low volume vehicle must be manufactured from a material with sufficient wall thickness that drilling and tapping will provide the correct thread for the appropriate rod end to screw directly into.

7.27.2

For example, 12 mm (½") nominal bore schedule 80 tubing has an outside diameter of 22 mm (7/8"), which can be tapped to accept a 16 mm (5/8") rod end.

7.27.3

A steering drag-link or tie-rod incorporated within a steering system in a low volume vehicle must not be welded, except in the case of a stitch-welded reinforcement strip for an MC-class vehicle, provided that:

7.27.3

'MC-class' is a 4WD off-road type vehicle.

(a) the drag-link or tie-rod is manufactured from mild steel; and

(b) the welding is carried out in accordance with the requirements specified in 18.7.1 of 'Chapter 18 - Attachment Systems'.

7.28 Steering drag-link and tie-rod ends

7.28.1

A steering drag-link or tie-rod incorporated within a steering system in a low volume vehicle must use drag-link or tie-rod ends that are either:

(a) unmodified ball-joint ends from a production vehicle with a front axle weight comparable to the vehicle to which the drag-link or tie-rod ends are fitted; or

(b) custom spherical bearing rod ends that meet the requirements specified in 7.28.2.

7.28.2

A custom spherical bearing rod end incorporated within a steering system in a low volume vehicle must:

(a) be of premium quality, having a radial load-rating appropriate to the rod end size of not less than that specified in Table 7.2; and

(b) be designed for axial loading; and

(c) be positioned in such a way that binding of the end can not occur throughout the full range of suspension travel; and

(d) incorporate engagement of the male thread section of the rod ends into the drag-link or tie-rod tube of not less than one and a half times the diameter of the thread section to ensure the rod ends are securely held in position; and

(e) be injected with a high quality flexible lining material such as Kevlar; and

(f) incorporate retaining washers to prevent bearing pull-out if the ends become worn; and

(g) incorporate a shank length and a bolt size that is in accordance with Table 6.2 of 'Chapter 6 - Suspension Systems'; and

(h) incorporate fasteners to clamp the rod ends to the steering arms that:

(i) are a close tolerance fit both in the rod end bearing and in the steering arm; and

(ii) are loaded by the steering arms on the shank section of the fasteners only; and

(iii) meet all other requirements specified for fasteners in a critical location in 18.4 to 18.6 in 'Chapter 18 - Attachment Systems'.

7.28.2(c)

High-misalignment bearings should be used for large angular movement situations rather than packing washers.

7.28.2(d)

A 'witness hole' should be drilled into the tube to enable inspection of thread engagement.

7.28.2(e)

Teflon can swell and extrude, therefore should not be used in this application.

7.28.2(h)(i)

Any taper previously machined into a steering arm must, where a spherical rod end is attached, be removed.

ROD END SIZE	LOAD-RATING
▪ 10 mm (3/8")	1770 kg (3900 lb) radial load
▪ 11 mm (7/16")	1900 kg (4200 lb) radial load
▪ 12 mm (1/2")	3020 kg (6650 lb) radial load
▪ 16 mm (5/8")	3340 kg (7350 lb) radial load
▪ 19 mm (3/4")	5230 kg (11,500 lb) radial load

Table 7.2 Custom spherical bearing rod end (radial) load-rating table

Steering system geometry requirements:

7.29 Steering system geometry inspection

7.29.1

A low volume vehicle that has been fitted with a new or changed steering system must undergo an assessment to ensure that both front and rear axles are:

(a) parallel to each other; and

(b) square to the longitudinal centre-line of the vehicle.

7.29.2

A low volume vehicle that has been fitted with a new or changed steering system, or has had a steering rack fitted or relocated, must undergo a full steering geometry swing-check throughout the full range of the vehicle's suspension travel, with springs removed, and results recorded, by an appropriately authorised low volume vehicle certifier, to ensure that:

(a) bump-steer is either not present, or is at an acceptably minimal level; and

(b) no ball-joint or steering joint binding is present; and

(c) no rubbing or wearing of any suspension or steering componentry is evident.

7.30 Rack & pinion steering and IFS geometry

7.30.1

In the case of a low volume vehicle that is fitted with an independent front suspension, and a rack and pinion steering system: (see Diagram 7.6)

(a) the length of the rack and pinion assembly must be as close as practicable to the distance between the suspension a-arm inner pivots; and

(b) the steering tie-rods, and the lower suspension a-arms, must be as parallel as practicable to each other, throughout the full range of suspension travel.

7.29.1

This can be assessed through a wheel alignment report, or by thorough visual inspection or use of a string-line check by a Low Volume Vehicle Certifier.

7.29.2

The inspection should be in accordance with the procedures specified for suspension and steering bump-steer swing-check, available in an Information Sheet from LVV Certifiers, or the LVVTA (Inc).

7.30.1

As a very rough starting-point guideline, the rack and pinion length should be within 10% of the distance between the suspension pivot points.

It is very important to carry out the bump-steer swing-check while the system is mocked-up before final installation, to ensure the correct rack positioning.

This requirement also applies to a production vehicle that has undergone a rack and pinion change.

7.30.1

See 'Useful Information' section at the back of this chapter for more information about bump-steer.

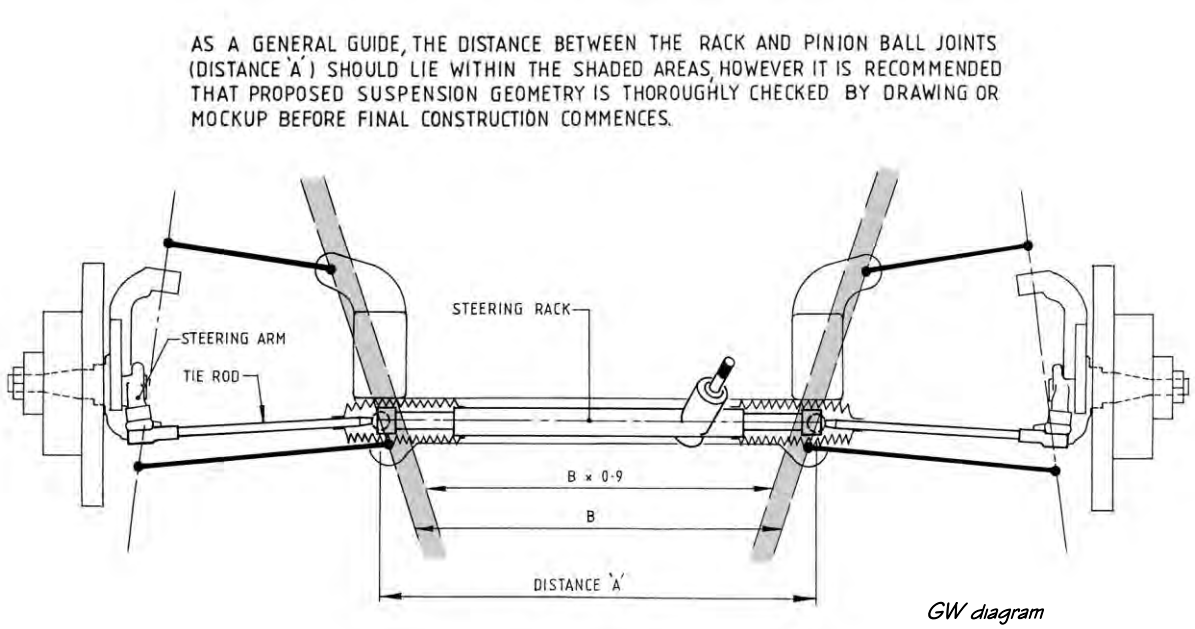


Diagram 7.6 Rack & Pinion steering geometry with independent front suspension

7.31 Steering box drop-arm geometry

7.31.1

A steering box drop arm fitted to a low volume vehicle must operate in an arc that:

(a) does not exceed a total of 90 degrees, consisting of an equidistant amount of 45 degrees on either side of the straight-ahead position; and

(b) does not allow the steering system to:

(i) go over-centre at either extreme of lock; or

(ii) bind throughout the steering travel.

7.32 Steering box drop-arm and drag-link geometry

7.32.1

In the case of a low volume vehicle that is fitted with a steering box attached near the firewall, with a longitudinal drag-link operating the right side steering arm, the drag-link must: (see Diagram 7.7)

7.32.1

A drag-link that is not parallel to, or the same length as the four-bars or radius rods, will create a bump-steer situation.

See the 'Useful Information' section at the back of this chapter for more information about bump-steer.

(a) be positioned at 90 degrees to the steering box drop-arm when the front wheels are aimed directly forward; and

(b) be positioned as parallel as possible to the suspension four-bars or radius rods; and

(c) be as close as practicable to the same length as the suspension four-bars or radius rods.

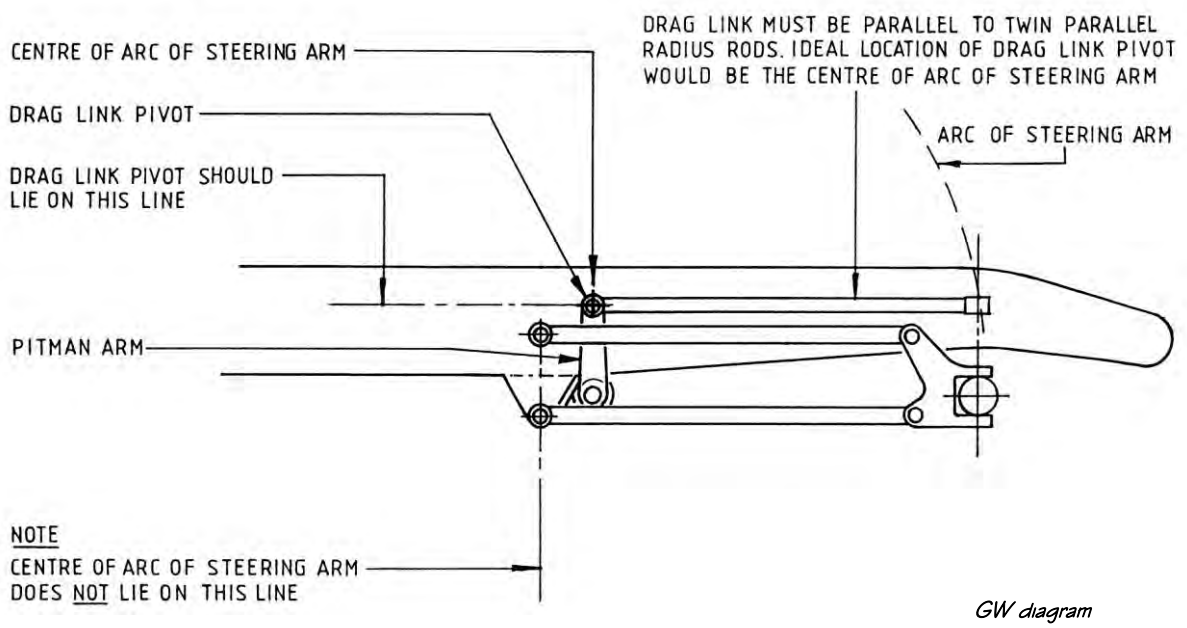


Diagram 7.7 Steering box drop-arm & drag-link geometry

7.32.2

In the case of a low volume vehicle that is fitted with a steering box attached toward the front of the chassis, with a transverse drag-link operating the left side steering arm, the drag-link must:

(a) be parallel to the axle; and

(b) be positioned at 90 degrees to the steering box drop-arm when the front wheels are aimed directly forward.

7.32.2

This system is known as a 'cross-steer' system.

7.33 Steering travel and lock-stops

7.33.1

A rack and pinion or box steering system in a low volume vehicle must be designed in such a way that:

7.33.1

This is important, as continued steering input after the travel has reached its end will result in loading of the chassis section or cross-member to which the rack and pinion or box is attached.

(a) the rack and pinion or box lock-stops prevent the continuation of steering, before the rack and pinion or box has reached the limit of its travel; and

(b) steering lock-stops are incorporated to cease steering travel to prevent the wheel and tyre assemblies coming into contact with the chassis, body, or other suspension or steering components.

7.33.1(a)

In-built steering stops within a rack and pinion assembly, achieve this requirement.

7.34 Caster angle geometry

7.34.1

The amount of positive caster required to be incorporated within the steering of a low volume vehicle is:

(a) in the case of an independent front suspension, with engine weight positioning similar to that of a typical high-volume sedan-type vehicle, 1-3 degrees; or

(b) in the case of an independent front suspension, with engine weight positioning significantly set back compared with a typical high-volume sedan-type vehicle, 3-6 degrees; or

(c) in the case of a beam or tubular axle front suspension, with engine weight positioning similar to that of a typical high-volume sedan-type vehicle, 4-8 degrees; or

(d) in the case of a beam or tubular axle front suspension, with engine weight positioning significantly set back compared to a typical high-volume sedan-type vehicle, 6 or more degrees.

7.34.1

Achieving the correct amount of caster is a very important part of getting a good steering set-up, and has been one of the most common problems with hobby cars over the years, with builders typically not getting enough caster into the front end.

These figures are approximate and can be varied at the discretion of the LVV Certifier in certain circumstances. If in doubt when setting up, always go for more caster than less.

See more information on caster in the 'Useful Information' section at the end of this chapter.

7.35 Steering system scrub-radius geometry

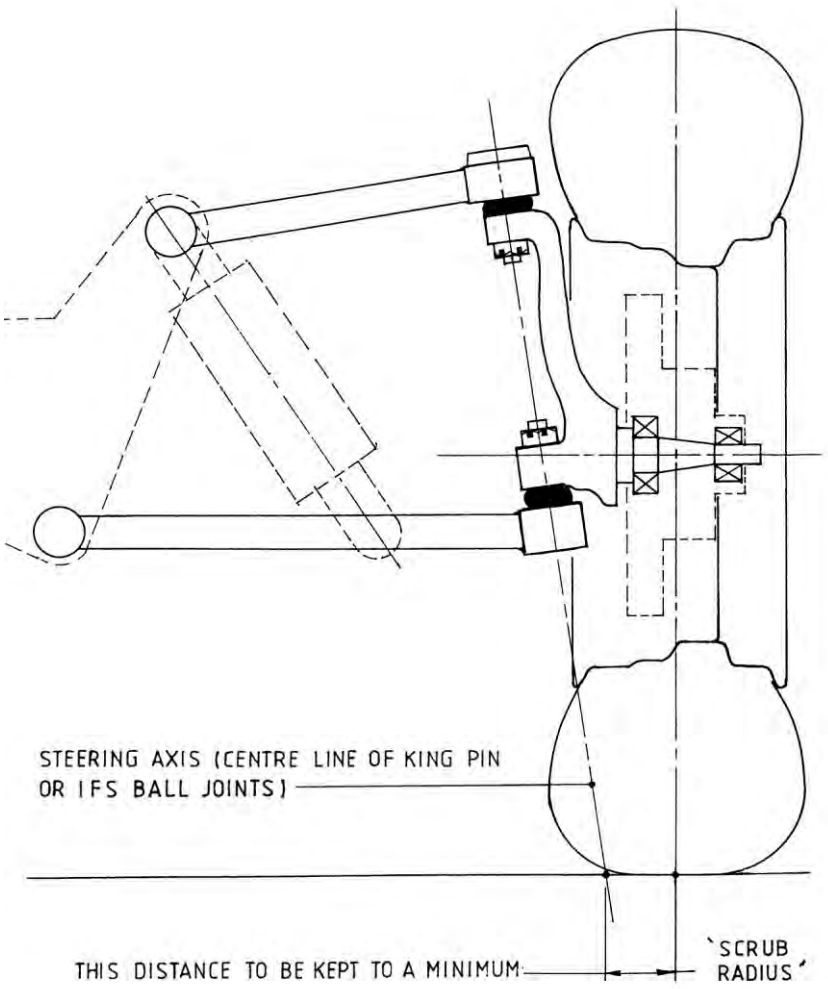
7.35.1

The centre-line of a front wheel-rim on a low volume vehicle must be positioned as closely as practicable to the centre-line of the king-pins, or in the case of a vehicle with an independent front suspension, the intersecting line of the upper and lower ball-joints. (see Diagram 7.8)

7.35.1

Keeping wheel off-sets to a minimum at the front helps toward achieving good scrub-radius.

Excess scrub-radius can have a negative effect on braking performance, and increase road-shock back to the driver through the steering wheel.



GW diagram

Diagram 7.8 Scrub-radius geometry

7.36 Ackermann angle geometry

7.36.1

A low volume vehicle that incorporates a custom-built suspension system must incorporate within its steering system, some ackermann angle geometry (see Diagram 7.9).

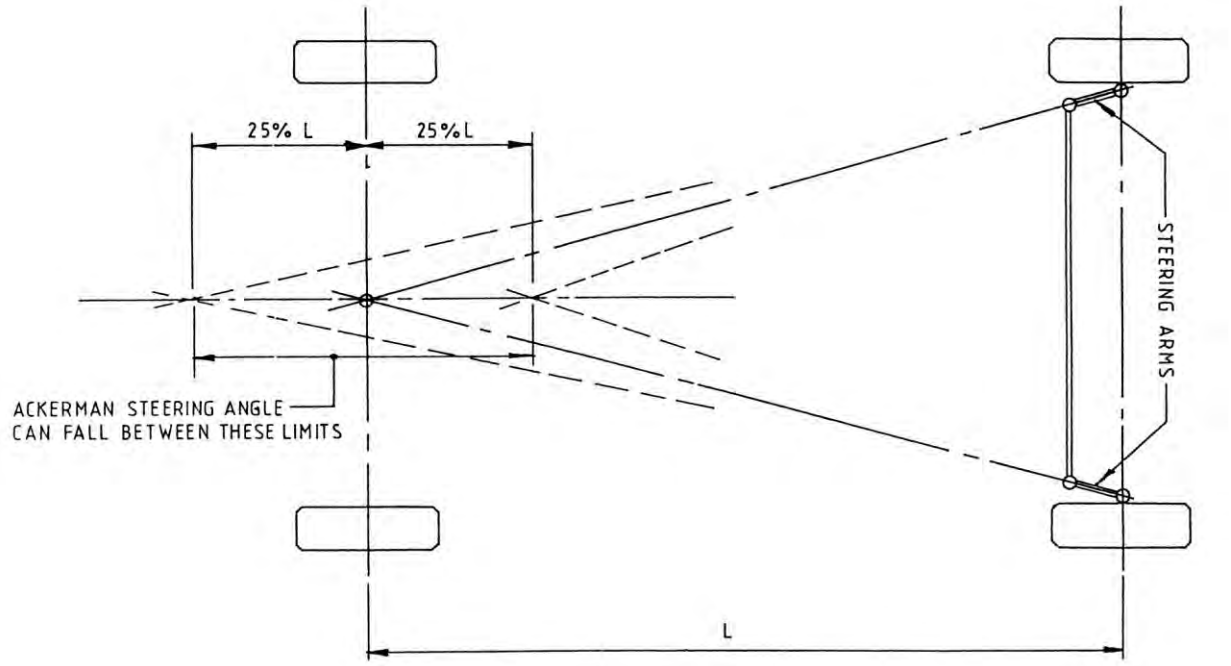
7.36.2

A low volume vehicle that incorporates an OEM suspension assembly must not, if the suspension assembly incorporates anti-ackermann angle geometry, incorporate any more anti-ackermann geometry than that built into the OEM donor vehicle (see Diagram 7.9).

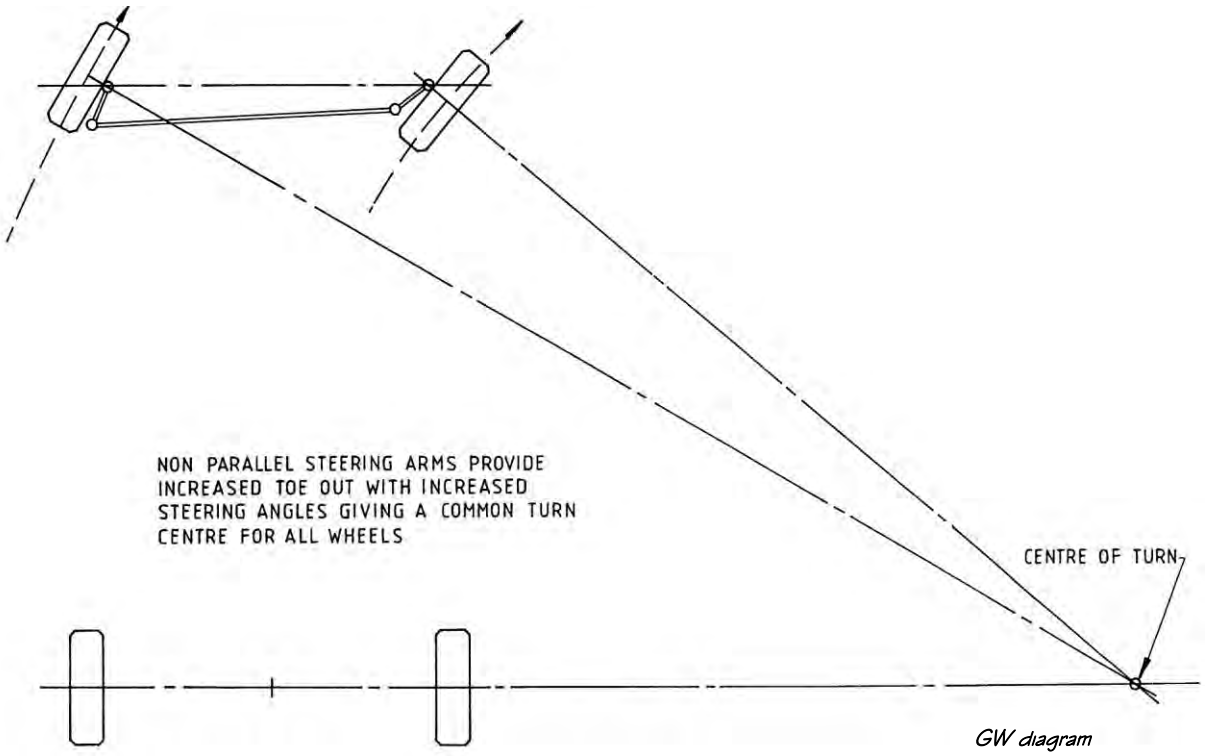
7.36.2

Some OEM IFS units such as HQ Holden actually have a small amount of anti-ackermann built in.

See the 'Useful Information' section at the end of this chapter for more information on ackermann angle geometry.



GW diagram



GW diagram

Diagram 7.9 Ackermann geometry

7.37 Steering system scrub-line geometry

7.37.1

A steering system within a low volume vehicle must be attached in such a way that no part of the steering system is positioned below an area defined by: (see Diagram 7.10)

(a) a line from the bottom of the right side front wheel-rim to the road contact patch of the left side front tyre; and

(b) a line from the bottom of the left side front wheel-rim to the road contact patch of the right side front tyre.

7.37.1

This needs to be checked with the full vehicle weight on the suspension.

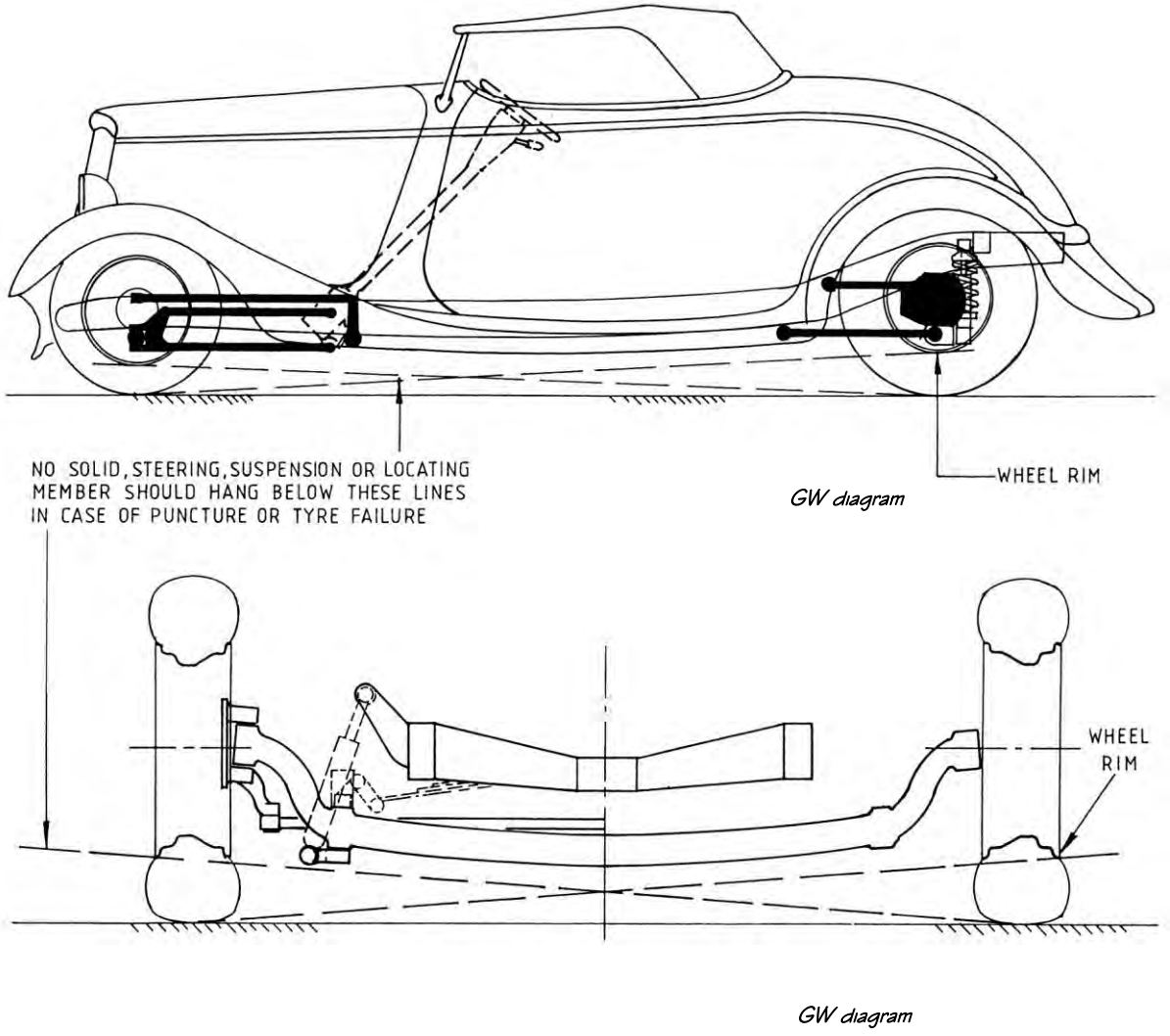


Diagram 7.10 Scrub-line geometry

7.38 Geometry adjustment

7.38.1

A steering system fitted to a low volume vehicle must incorporate provision for the correct adjustment of toe-in and toe-out.

Additional requirements for all steering systems:

7.39 Steering quickeners and reverse-rotation boxes

7.39.1

A custom-manufactured or aftermarket steering 'quickener' fitted to a low volume vehicle, must be individually approved in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc).

7.39.2

A custom-manufactured or aftermarket steering reverse-rotation box fitted to a low volume vehicle, must be individually approved in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc).

7.40 Attachment of steering system components

7.40.1

All fasteners incorporated in steering system attachment, modification, or adaptation within a low volume vehicle, must meet all requirements specified from 18.2 to 18.6 inclusive in 'Chapter 18 - Attachment Systems'.

7.41 Welding of steering system components

7.41.1

A component within a steering system in a low volume vehicle must not be welded, except where specifically stated for steering intermediate shafts, steering rack and pinion housings, and custom steering box drop arms.

7.41.2

A component within a steering system in a low volume vehicle specified in 7.41.1 may only be welded if:

7.41.1

Note that welding is, as a rule, not permitted within any 'critical' steering components. Any welding referred to here is restricted to situations where no other option is available.

(a) in the case of a vehicle manufacturer's original equipment, the component is operating in the same application for which it was originally designed; or

(b) a steering component has been modified or custom-manufactured, due to no other practical option being available, in which case:

(i) the component must meet all requirements specified in 18.9 'critical function welding requirements' in 'Chapter 18 - Attachment Systems'; and

(ii) the modification or custom-manufacturing process must be carried out by a person who is professionally engaged in motor vehicle construction, has substantial experience in steering component manufacture, and who is specifically nominated in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc).

7.41.2

See the 'Useful Information' section at the end of this chapter for information on welding castings and forgings.

General requirements:

7.42 General safety requirements

7.42.1

A steering system and its associated components fitted to a low volume vehicle must be suitably matched and appropriate for their application.

7.42.2

Modifications, adaptations, and attachments of any steering system and associated components in a low volume vehicle must incorporate sound automotive engineering principles and procedures.

7.42.3

All steering components incorporated within a steering system in a low volume vehicle must be appropriately suited to:

(a) the performance potential of the vehicle; and

(b) the weight of the vehicle over the steering axle.

7.42.4

A sprocket and chain system must not be used within a steering system in a low volume vehicle.

7.42.5

A low volume vehicle with the steering wheel and column assembly positioned to the left side of the longitudinal centre-line of the vehicle must not be certified to the Low Volume Vehicle Code if:

(a) it has been constructed in New Zealand; or

(b) converted to left-hand drive in New Zealand; or

(c) it has been constructed outside of New Zealand less than 20 years from the date of entry certification in New Zealand.

7.42.5

It has been illegal to build cars in left-hand drive form, or convert cars to left-hand drive, in NZ for many decades.

7.42.5(c)

This means that a LHD scratch-built replica vehicle cannot be LVV certified unless it was built in its country of origin over 20 years from the date of entry certification (first registration) in NZ.

Exclusions:

7.43 Motor-sport exclusions

7.43.1

A low volume vehicle for which a valid LVV Authority Card, that specifies 'Frontal Impact Protection System' has been issued, is not required to comply with 7.2, 7.12, or 7.13.

Useful information:

Scrub radius

The distance between the centre-line of the wheel, and the centre-line of the king-pins, or the IFS ball-joints, should be minimised (whilst still retaining adequate clearance between moving parts). Minimal scrub radius will:

- enhance steering feed-back under braking; and
- minimise road-shock through the steering wheel; and
- increase tyre life.

Ackermann geometry

Ackermann ensures correct wheel geometry and tyre contact during turning, for the most economic tyre wear, and maximum road adhesion, and to avoid excess tyre scuffing. Ackermann achieves this by enabling the inside front wheel to prescribe a tighter radius than the outside wheel during turns. Ackermann used to be considered important, but nowadays, some vehicle manufacturers incorporate very little ackermann geometry. Some race cars actually build in anti-ackermann, although there are good reasons why this shouldn't be applied to road-going vehicles.

A vehicle with a changed front end will have satisfactory ackermann if the donor vehicle is of a similar wheelbase to the vehicle being constructed.

Bump-steer

There are different kinds of bump-steer, all of which have detrimental effects on a vehicle's handling characteristics. The worst type of bump-steer, and one that must be avoided at all costs, is toe-out bump-steer, which can result in sudden changes in steering direction. An information sheet is available from LVV Certifiers or the Low Volume Vehicle Technical Association (Inc), that provides information and procedures for assessing, and ensuring against, bump-steer and other geometry issues. This Information Sheet can be obtained from LVVTA's website www.lvvta.org.nz.

Despite all the theory on causes and cures in this chapter for bump-steer, there's nothing better than carrying out a proper bump-steer swing-check. Have this done at early mock up stage by an experienced scratch-built LVV certifier

Caster angle geometry

Caster must be the most over-looked area in the basic suspension set-up of a hobby vehicle, with even professional hobby car builders sometimes not paying enough attention to this area when they are setting up the front end. Many of the hobby cars that have driven like rubbish over the years have done so simply because of a lack of positive caster.

Caster is the imaginary vertical line between the upper and lower ball-joints – and positive caster being the top ball-joint positioned rearward of the bottom ball-joint. Good-driving cars need plenty of positive caster. The reason you could ride your pushbike for a block with no hands on the handlebars when you were a kid, was because of the way the forks are designed – effectively with positive caster. On the other hand, the reason a shopping trolley is uncontrollable is because they are designed with negative caster, to enable easy manoeuverability.

It is caster that provides self-centering, and the tendency to want to 'track' straight and true, and it is this which provides the 'feel' that a nice-driving car gives. The only negative pay-back is that the more caster you build in, the heavier the steering becomes – so fit power steering - don't compromise your car's driveability by keeping manual steering and reducing the amount of caster to keep the steering light!

As a general rule of thumb, the range is between 1 and 8 degrees positive (check the requirements in the suspension geometry section for the varying figures for different front end types), and should increase as the amount of engine set-back increases. A rear-engined dragster can run anything up to 30 degrees – hard as hell to steer, but the car drives itself down the track! It's these same dramatic positive caster settings that cause the violent front-wheel wobble that you sometimes see when dragsters or altereds slow or back-up after the burn-out.

Care must be taken when setting up the front and rear ride height, to ensure that the correct amount of steering caster is incorporated into the steering system. The vehicle's finished stance must be established and mocked-up into position before the IFS beam is attached.

This process requires the wheel and tyre selection to be made at an early stage. If the beam is bolted into the chassis, you've got an opportunity to fix it later if you make a change that upsets the caster, but if the beam is welded into the frame, and it turns out to be wrong, you've got big troubles!

Steering system interference

If interference is encountered during engine positioning between the engine and part of the steering system, there is no reason why the engine can't be positioned across slightly to the left of centre (say, 20 mm [5 1/64"] or so), rather than compromising the steering system.

Rack and pinion steering systems

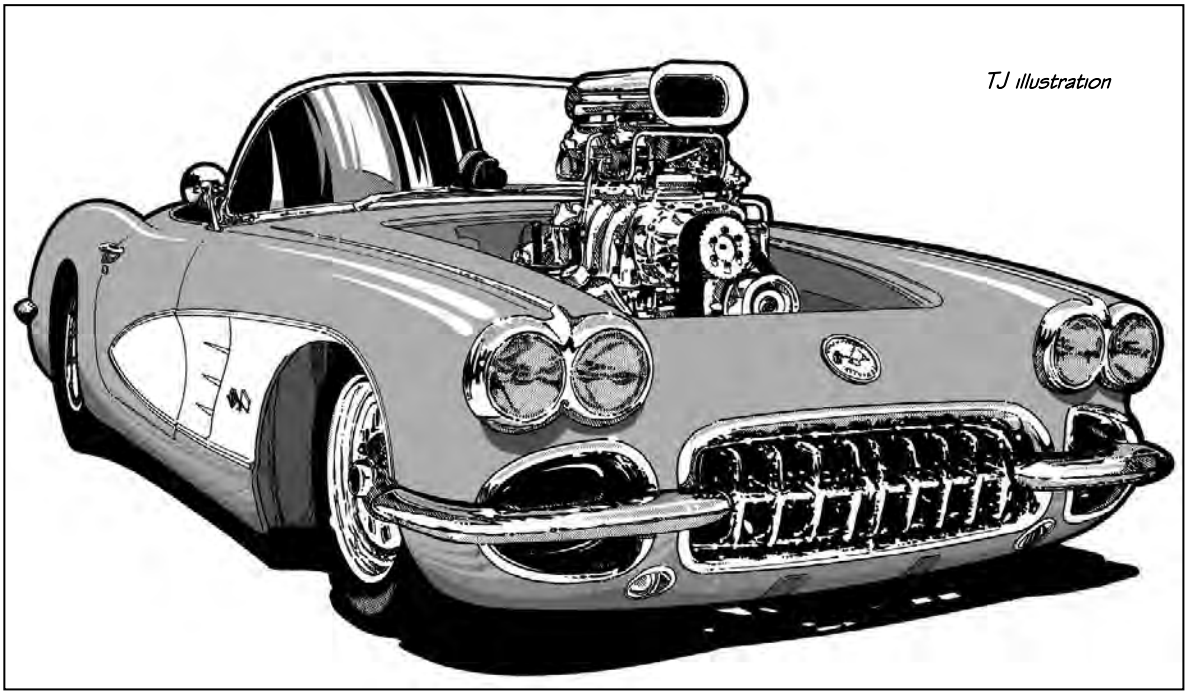
A rack and pinion steering system generally provides less steering effort than conventional steering boxes due to their virtually friction-free design. Therefore, less turns from lock to lock can be achieved by using a rack and pinion from the same, or even less, steering effort.

Welding of castings and forgings

A basic but very important engineering principle threaded throughout the whole LVV certification process in New Zealand is that a forging or casting in a critical situation like suspension, steering, or brakes, must not be heated and bent, or welded, except in highly controlled circumstances. A forging or casting that is heated during a welding process must be re-heat treated afterwards, and this can not be done correctly unless the exact molecular structure of the material of the forging or casting has been properly established beforehand by a metallurgist – which in turn enables the appropriate heat-treatment method to be established. This process is costly, and not practicable in one-off situations. There is a very real risk of changes occurring within the molecular structure of a steel forging or casting when a welding process is applied, particularly if too much heat is applied during the heating or welding process, and the problems that this can create are often irreversible.

If anyone has a legitimate need to do this, it may be allowed, but only after having received written approval from the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc) on a case-by-case basis.

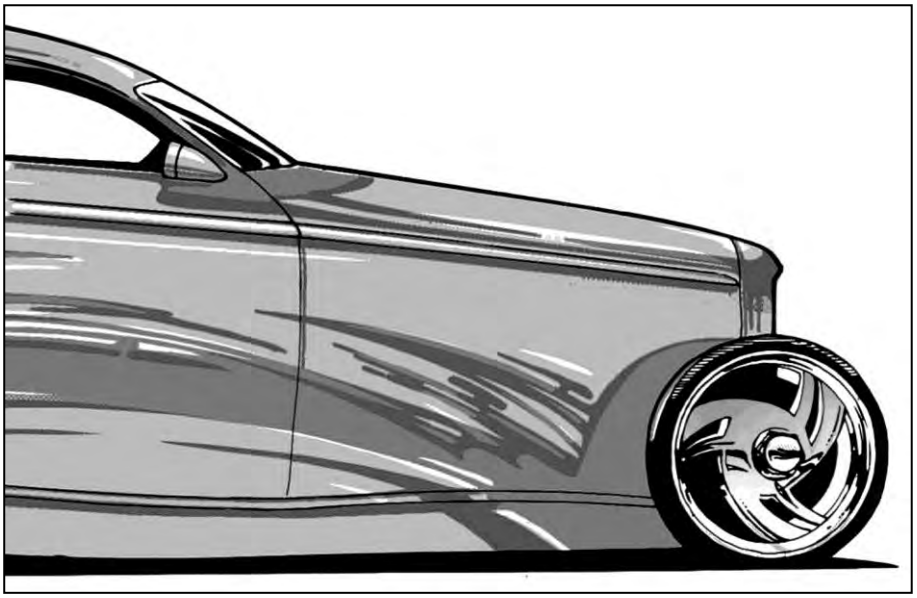
The old practice of heating and bending, or welding, forgings or castings is for the history books; better components and machining processes are available now, to the extent that these practices can be left behind in the 'good old days' forever!



TJ illustration

Chapter 8:

BRAKING SYSTEMS



TJ illustration

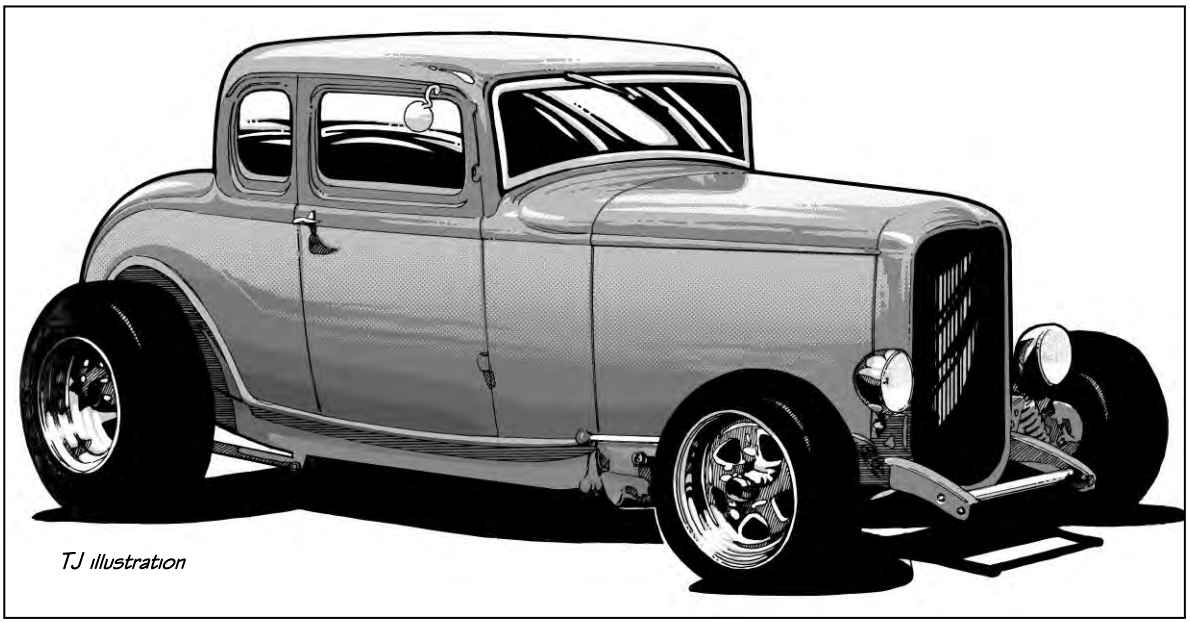
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Key: (for full key details, refer to 'Chapter 2 – About this Manual')

Normal type: Provisions of the NZ Car Construction Manual for all vehicles
Normal type in shaded box: Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates
Italic type: *Extracts from any relevant LVVTA Low Volume Vehicle Standards*
Script type: Helpful hints, tips, explanations, clarifications, and interpretations
Shaded text & dotted vertical stroke in margin: Latest amendments since previous version



TJ illustration

CHAPTER 8: BRAKING SYSTEMS

Introduction:

The need for an efficient, reliable, and durable braking system is considered one of the two most important aspects of a hobby car's design and construction, along with the steering system. It is vital that the entire braking system is thoroughly thought out, and designed around the proposed weight and performance potential of the vehicle being built, before the purchase of any individual components begin. This will ensure that the braking system ultimately becomes a matched combination of components that will work in harmony, providing effective and well-balanced braking, both in one-off performance, and ability to resist brake-fade during repeated applications.

Note that where a production vehicle is fitted with its original braking system or braking system components in their original location, the requirements in this chapter do not apply.

Technical Requirements:

8.1 Brake system component compatibility

8.1.1

All components used within a braking system on a low volume vehicle must be purposely designed for automotive applications.

8.1.2

Brake components fitted to a low volume vehicle must be suitably matched for brake balance and bias, taking into account vehicle weight, engine set-back, and tyre size.

8.1.2

Tyre width can have a considerable effect on the front to rear brake balance, which is critical to optimising overall braking performance.

8.2 Disc and drum requirements

8.2.1

Brake disc and drum assemblies fitted to a low volume vehicle must be compatible with the weight and performance potential of the vehicle to which they are fitted, by incorporating:

(a) *braking surface swept area in accordance with the requirements specified in 8.2.2; and*

(b) *donor disc or drum material thickness that is not machined beyond the limitations specified by the brake component manufacturer.*

8.2.2

Brake disc and drum selection must be suitably matched to the performance potential of the low volume vehicle to which they are fitted, and Tables 8.1 and 8.2 should be used as a guide for appropriate component selection. (see Tables 8.1 and 8.2)

VEHICLE TYPE	VEHICLE WEIGHT RANGE	ENGINE HORSE POWER RANGE	POWER - WEIGHT RATIO (median)	FRONT DISC ROTOR SIZE (see Table 8.2 for typical sources)	FRONT CALIPER SIZE & TYPE (see Table 8.3 for typical sources)
▪ Lotus 7 replica ▪ Light-weight space-frame sports or classic/vintage special	500 - 800 kg (1100 - 1760 lb)	40 - 75	11.3	245 mm x 10 mm (S)	OEM small single-pot or OEM 2-pot
		75 - 150	5.8	250 mm x 12 mm (S)	OEM small single-pot or OEM 2-pot
		150 - 300	2.8	280 mm x 20 mm (V)	OEM medium single-pot or OEM 2-pot (75 mm [3"] pad)
		300 - 450	1.7	280 mm x 25 mm (V)	OEM medium single-pot or OEM 2-pot (75 mm [3"] pad)
▪ Heavy-weight space-frame sports special ▪ Medium-weight ladder-chassis sports car (MGTF replica) ▪ Light-weight hot rod (T-bucket, f-glass roadster) ▪ Small unit-construction sedan (Civic, Mazda 323)	800 - 1150 kg (1760 - 2530 lb)	75 - 150	8.7	250 mm x 12 mm (S)	OEM medium single-pot or OEM 2-pot (75 mm [3"] pad)
		150 - 300	4.3	280 mm x 20 mm (V)	OEM medium single-pot, OEM 2-pot (75 mm [3"] pad), or aftermarket small 4-pot
		300 - 450	2.6	280 mm x 25 mm (V)	OEM medium single-pot, OEM 2-pot (75 mm [3"] pad), or aftermarket small 4-pot
		450 - 600	1.8	300 mm x 28 mm (V)	Aftermarket medium size 4-pot (120 mm [4 ¾"] pad)

▪ Heavy-weight ladder-chassis sports car (Cobra) ▪ Medium-weight hot rod (steel coupe, pick-up) ▪ Large unit-construction sedan (Camaro, Falcon, Commodore) ▪ Large unit-construction Japanese (Skyline, GTO)	1150 - 1500 kg (2530 - 3300 lb)	150 - 300	5.8	280 mm x 20 mm (V) 280 mm x 25 mm (V)	Standard single-pot or OEM 2-pot sliding type
		300 - 450	3.5	300 mm x 28 mm (V)	OEM 2-pot sliding type or aftermarket medium 4-pot
		450 - 600	2.5	310 mm x 28 mm (V)	OEM 2-pot sliding type, OEM medium 4-pot, or aftermarket medium 4-pot
		600 - 750	1.9	330 mm x 30 mm (V)	OEM large 4-pot, or aftermarket medium 4-pot, or aftermarket large 4-pot
▪ Heavy-weight hot rod (30s & 40s sedan) ▪ Full size body/chassis car (50s & 60s USA sedan)	1500 - 2000 kg (3300 - 4400 lb)	150 - 300	7.7	280 mm x 25 mm (V)	OEM medium single-pot or OEM 2-pot sliding type
		300 - 450	4.6	300 mm x 28 mm (V)	OEM 2-pot sliding type or aftermarket medium 4-pot
		450 - 600	3.3	300 mm x 32 mm (V) 330 mm x 30 mm (V)	Aftermarket medium 4-pot, or OEM & aftermarket large 4-pot
		600 - 750	2.5	300 mm x 35 mm (V) 332 mm x 32 mm (V)	Aftermarket medium 4-pot, or OEM & aftermarket large 4-pot

Notes to accompany table 8.1:

- (S) denotes solid disc rotor, and (V) denotes ventilated disc rotor.
- Disc rotor and caliper sizes and types are those considered as ideal for the application, and while it is recommended that selections are made as closely as possible for the application, the table is only a guide. Despite the selection made, the one-off performance and cyclic brake-fade tests conducted during the certification process will determine what is acceptable. By following the table, you will optimize your chances of meeting the certification requirements.
- Table 8.3 should be referred to for assistance in brake caliper selection and sourcing.
- The emphasis on braking requirements is on the front brake components, as the front brakes do around 70% of the total stopping work. Therefore, it is recommended that:
  - in all but the most extreme combinations of performance and weight, solid discs will perform satisfactorily at the rear; and
  - rear disc rotor diameter should either be within approximately 15% of the front disc rotor diameter, or maintain the same front to rear relationship as found on the front disc rotor donor vehicle.
- An after-market cross-drilled and slotted sport disc rotor can be considered approximately as efficient as a non-cross-drilled and non-slotted disc rotor of the next diameter up.
- 330 mm (13") and larger diameter disc rotors will require 17", and possibly 18" wheels, to clear the calipers.

Table 8.1 Disc rotor size application guide table

FRONT DISC ROTOR SIZE	TYPICAL DISC ROTOR DONOR VEHICLES & SOURCES
▪ 247 mm x 9.6 mm (9 23/32" x 3/8") (S)	Ford Zephyr Mk3, and very small Japanese makes
▪ 247 mm x 12.5 mm (9 23/32" x 1/2") (S)	Ford Escort Mk2, and Ford Cortina Mk3 Mk4 and Mk5
▪ 254 mm x 8.2 mm (10" x 5/16") (S)	Aftermarket brands such as Wilwood, Outlaw, AP etc
▪ 280 mm x 20.6 mm (11" x 13/16") (V)	Honda and other common medium-sized Japanese makes
▪ 287 mm x 25.5 mm (11 5/16" x 1") (V)	XY – XF Ford Falcon

▪ 276 mm x 24.0 mm (10 7/8" x 5/16") (V)	HQ – HZ Holden
▪ 290 mm x 22.0 mm (11 27/64" x 7/8") (V)	VK – VS Holden Commodore
▪ 295 mm x 28.0 mm (11 39/64" x 1 7/64") (V)	VT – on Holden Commodore
▪ 300 mm x 21.0 mm (12" x 13/16") (V)	Aftermarket brands such as Wilwood, Outlaw, AP etc
▪ 300 mm x 25.0 mm (12" x 1") (V)	Nissan Skyline and other larger Japanese makes, aftermarket brands such as Wilwood, Outlaw, AP etc
▪ 310 mm x 30.0 mm (12 13/64" x 1 3/16") (V)	Aftermarket brands such as Wilwood, Outlaw, AP etc
▪ 320 mm x 30.0 mm (12 39/64" x 1 3/16") (V)	Aftermarket brands such as Wilwood, Outlaw, AP etc
▪ 328 mm x 28.0 mm (12 29/32" x 1 7/64") (V)	HSV Holden Commodore
▪ 332 mm x 32.0 mm (13 5/64" x 1 17/64") (V)	Aftermarket brands such as Wilwood, Outlaw, AP etc
▪ 340 mm x 32.0 mm (13 25/64" x 1 17/64") (V)	Aftermarket brands such as Wilwood, Outlaw, AP etc
▪ 350 mm x 32.0 mm (14" x 1 17/64") (V)	Aftermarket brands such as Wilwood, Outlaw, AP etc

Table 8.2 Disc rotor source table

8.2.3

Brake disc caliper selection must be suitably matched to the performance potential of the low volume vehicle to which they are fitted, and Table 8.3 should be used as a guide for appropriate component selection. (see Table 8.3)

FRONT CALIPER TYPE	TYPICAL CALIPER DONOR VEHICLES & SOURCES
▪ OEM small single-pot	60 - 70 mm (2 23/64" – 2 49/64") pad; small non-performance Japanese makes
▪ OEM medium single-pot	100 mm (4") pad; Toyota Corolla, Honda Accord, Mitsubishi
▪ OEM large single-pot sliding type	Large pad; HQ-HZ Holden, XA-XF Falcon
▪ OEM small 2-pot	60 mm (2 23/64") pad; Cooper S, Datsun 1600, common modern small Japanese makes
▪ OEM medium 2-pot	75 mm (3") pad; Zephyr, Escort, Cortina, & other British makes, & Datsun Z-series
▪ OEM 2-pot sliding-type	Toyota Soarer, Subaru Legacy, Mitsubishi Diamante & Evo 1-4, some Honda Accord
▪ Aftermarket 2-pot	50 mm (2") pad; Wilwood and others, generally intended for rear
▪ OEM medium 4-pot	Subaru WRX STI, Mazda Series 4-on RX7, Nissan Skyline & 280 -300 Z-series
▪ OEM large 4-pot	R33 Nissan Skyline, Mitsubishi Evo 5-on, Porsche, late S2 XJ6 Jaguar
▪ Aftermarket small 4-pot	Wilwood Dynalite, Outlaw 2000
▪ Aftermarket medium 4-pot	Wilwood Superlite, Outlaw 3000
▪ Aftermarket large 4-pot	Wilwood Grand National, AP, Brembo, etc

Table 8.3 Brake caliper source table

8.2.4

Where a brake disc adaptation has taken place on a low volume vehicle, the adaptation must not incorporate:

(a) *any welding to any cast or forged suspension upright or stub axle, or steering arm; or*

(b) *any reduction of the spindle diameter by machining or any other means; or*

(c) *any alteration to the original radii incorporated within the spindle.*

8.2.4 does not apply to a low volume vehicle built or modified before 1992, provided that the original radii has been replicated during the machining process.

8.2.4(b)

The practice of machining a stub axle spindle to shorten the length of it is allowed.

8.2.5

Original equipment manufacturer or aftermarket brake rotors fitted to a low volume vehicle must not be drilled or modified in any other way, except where provided as part of the original specification by the brake rotor manufacturer.

8.3 Pedal assembly requirements

8.3.1

A custom-manufactured brake pedal fitted to a low volume vehicle must be manufactured from a material having a thickness of equal or greater strength than 8 mm (5/16") mild steel.

8.3.1 does not apply to a low volume vehicle built or modified before January 1992, provided that the pedal appears to be of sound design and in good condition.

8.3.1

A custom-manufactured brake pedal may be made from 5 mm (13/64") thickness material in cases where the pedal length is unusually short, such as in a typical Lotus 7 style vehicle.

If using aluminium for a brake pedal, the material thickness will need to be between 150% and 200% of the specified mild steel thickness.

Alternative pedal fabrication methods may be used in special applications (such as race-car type sheet-metal pedals) on a case-by-case basis, provided approval in writing is obtained from the LVVTA Technical Advisory Committee.

8.3.2

A brake pedal fitted to a low volume vehicle must operate without binding or interfering with any other components.

8.3.3

A brake pedal fitted to a low volume vehicle must:

(a) be positioned where a brake pedal could reasonably be expected to be located; and

(b) have no obstruction positioned between the brake pedal and the accelerator pedal; and

(c) have sufficient clear space around the brake pedal to enable the pedal to be safely accessed and operated; and

(d) be able to be comfortably operated; and

8.3.3(b)

A steering column is considered an obstruction if positioned between the brake and accelerator pedals.

8.3.3(d)

The ideally positioned brake pedal can be operated with the ball of the foot with the heel positioned on the floor.

(e) provide smooth progressive application of the braking system.

A low volume vehicle that was built or modified before 1992 incorporating a steering column positioned between the brake and accelerator pedals is not required to comply with sub-clause (b) of 8.3.3.

8.3.4

A brake pedal fitted to a low volume vehicle must be constructed from a single piece of material, except for:

(a) the footplate; or

(b) the attachment of a boss or sleeved end of a pendulum design that, upon the failure of the attaching weld, would still enable the pedal to actuate the master cylinder; (see Diagram 8.1) or

8.3.4

'Through-floor' brake pedals (where the master cylinder is beneath the vehicle floor) are allowed provided that they meet the same requirements specified in 8.3.4.

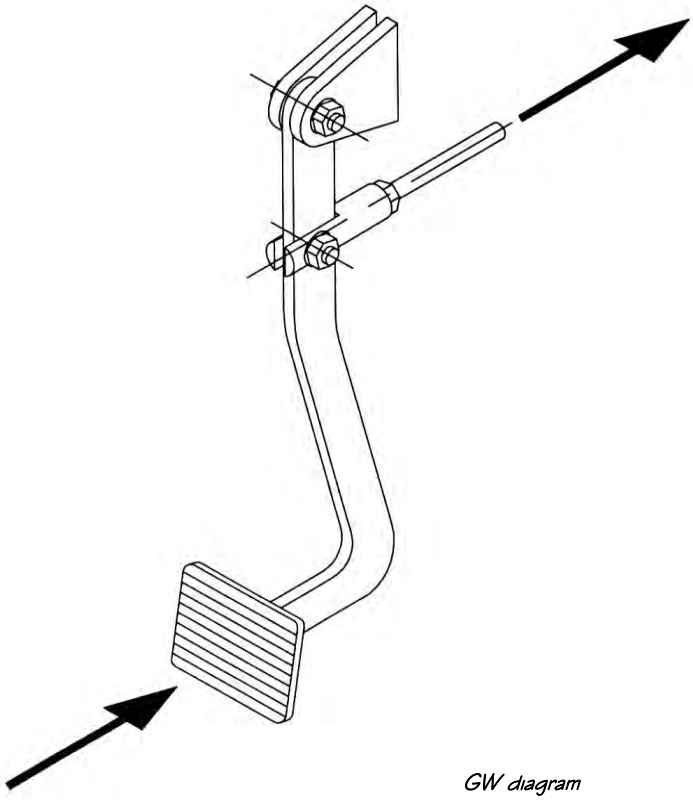


Diagram 8.1 Pendulum-design brake pedal assembly

(c) the attachment of an offset crank design only if accompanied by written approval from the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc). (see Diagram 8.2)

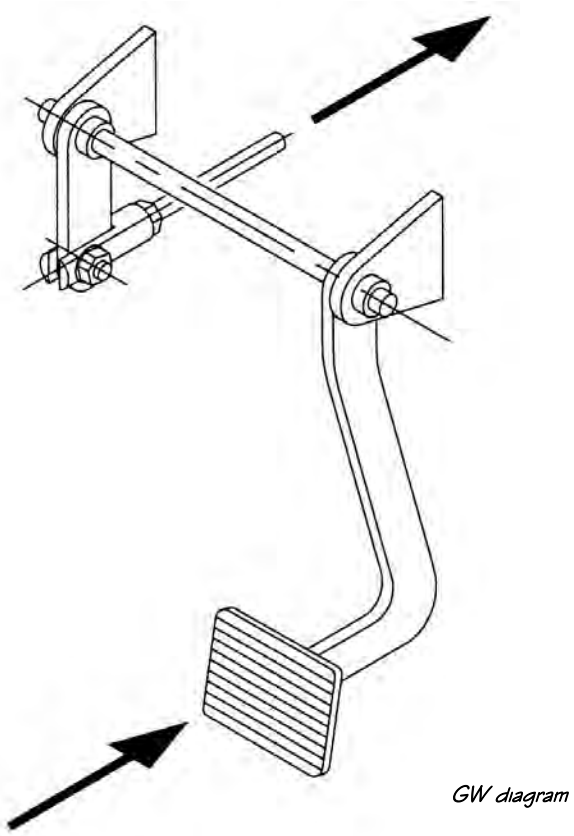


Diagram 8.2 Offset crank-design brake pedal assembly

8.3.4 does not apply to a low volume vehicle built or modified before 1992, provided that 8.15.1 is complied with.

8.3.5

A brake pedal assembly fitted to a low volume vehicle must incorporate:

(a) *an effective return spring; and*

(b) *a positive return stop; and*

(c) *an acceptable amount of free pedal movement before the braking system is actuated; and*

(d) positive retention of the pivot pin.

8.3.5(a)

An efficient return spring can include the spring incorporated within the booster (servo).

8.3.5(b)

A positive return stop is designed to prevent the push-rod from being able to fall out of the back of the master cylinder, and must be an independent pedal stop - not the washer and circlip within the master cylinder or booster.

8.3.6

A brake pedal push-rod fitted to a low volume vehicle must:

(a) be manufactured from material of a diameter appropriate to its length; and

(b) not incorporate any joins except for the attachment of end fittings; and

(c) not incorporate any welding, except in the case of an unmodified OE push-rod, which was carried out by the original high volume vehicle manufacturer.

8.3.6(c)

'High volume vehicle' means a production vehicle.

8.3.6 does not apply to a vehicle built or modified before 1992, provided that the non-destructive test requirements specified in 18.9.2 of 'Chapter 18 - Attachment Systems' are met.

8.3.7

A brake pedal push-rod fitted to a low volume vehicle must be positioned in such a way as to correctly align with the master cylinder or booster, and must not:

(a) incorporate any bends or changes of direction throughout its length; or

(b) travel through such an arc that excessive side-loading into the master cylinder or servo results; or

(c) operate in such a way that it binds or interferes with any other components.

8.3.8

A relocated or remounted brake pedal assembly must be located on a part of the structure of a low volume vehicle with sufficient strength and rigidity to securely attach and support the assembly during application of all normal and emergency braking loads.

8.3.9

A custom pedal box assembly fitted to a low volume vehicle must be:

(a) manufactured by a recognised aftermarket supplier of braking system components for motor-sport purposes; or

(b) designed so that a total failure of braking control cannot occur due to any individual component failure.

8.3.10

The braking system in a low volume vehicle must feature a brake pedal ratio that is designed to provide a comfortable operating balance between the length of travel and amount of force required to effect brake operation, which as a guide, should be:

(a) in the case of boosted brake systems;

(i) no less than 4:1; and

8.3.10

A 6:1 or 7:1 ratio is recommended for non-boosted systems, however, it is recognised that a particularly light vehicle built primarily for motor-sport purposes could get away with as little as a 4:1 non-boosted pedal ratio.

After-market pedal system manufacturers Wilwood and Tilton both supply a 6.25:1 system for non-boosted brake systems.

(ii) no more than 6:1;

or

(b) in the case of non-boosted brake systems;

(i) no less than 5:1; and

(ii) no more than 7:1.

8.3.11

An adjustable balance-bar assembly which actuates twin master cylinders in a low volume vehicle must:

(a) *be capable of being securely locked into position to prevent unintended changes in front to rear brake balance; and*

(b) *in the case of balance bar rods within a custom-built balance-bar assembly, be manufactured from a material of:*

(i) *appropriate strength; and*

(ii) *suitable diameter.*

8.3.12

A pedal assembly sourced from a high volume vehicle and fitted to a low volume vehicle must not be modified in any manner that could result in the weakening of the pedal.

8.4 Master cylinder requirements

8.4.1

A dual-circuit hydraulic master cylinder system must be fitted to:

(a) *all scratch-built low volume vehicles; and*

(b) *all modified production low volume vehicles which are fitted with any master cylinder other than that fitted by the original vehicle manufacturer.*

8.4.1 does not apply to a scratch-built vehicle built before 1992, or a production vehicle that has had a change in master cylinder before 1992.

8.4.2

A master cylinder reservoir fitted to a low volume vehicle must have a greater hydraulic fluid capacity than the combined total volume of all cylinders operating within the system.

8.3.12

'High volume vehicle' means a production vehicle.

8.4.1

A dual-circuit system must operate in such a way that a loss of fluid from one circuit (e.g. the front brakes), will not affect fluid supply to the other circuit (e.g. the rear brakes).

A dual-circuit system can be either one dual-circuit type master cylinder, or it can be two separate single-circuit master cylinders operated together by a balance bar assembly, with one cylinder operating the front brake circuit, and the other cylinder operating the rear circuit.

Note that a single reservoir can have two separate fluid chambers.

8.4.3

A relocated or remounted master cylinder must be located on a part of the structure of a low volume vehicle with sufficient strength and rigidity to securely attach the cylinder and support the cylinder during application of all normal and emergency braking loads.

8.4.4

When a master cylinder fitted to a low volume vehicle is at rest position, the master cylinder push-rod must have adequate clearance to ensure the release of fluid pressure.

8.4.4

Adequate clearance is considered to be approximately 1–2 mm (3/64" – 5/64").

8.4.5

A master cylinder and servo push-rod fitted to a low volume vehicle must be fitted with a dust-boot that is in good condition.

8.4.6

A master cylinder fitted to a low volume vehicle that was originally provided by the master cylinder manufacturer with rubber buffers at the servo end of the master cylinder, must continue to be fitted with rubber buffers.

8.4.6

The loss of these buffers is a common cause of sudden grabbing of the brake system.

8.5 Braking bias system requirements

8.5.1

A low volume vehicle may be fitted with one or more proportioning valves, provided that such valves are purposely designed for automotive applications.

8.5.2

A proportioning valve which is adjustable from inside a low volume vehicle must have the facility to be temporarily disabled or locked into a position of normal operation, to prevent unintended changes in front to rear brake balance occurring whilst the vehicle is being operated on public roads.

8.5.2

A motor-sport-type valve is acceptable provided the valve control lever or knob is removed, or protected by a hinged cover, for road use.

8.6 Vacuum servo system requirements

8.6.1

A vacuum servo system fitted to a low volume vehicle must provide and maintain sufficient vacuum to enable the braking system to operate safely at all engine speeds including idle.

8.6.1

A remote vacuum tank or accessory belt-driven vacuum pump may need to be fitted where the engine has a particularly high-lift camshaft, and as a result vacuum supply at low rpm is poor.

8.6.2

A remote vacuum servo fitted to a low volume vehicle, if exposed to or fitted near the road surface, must be protected by a chassis or sub-frame member, or purpose-designed shield, to prevent damage by irregular road surfaces or debris.

8.6.3

A vacuum brake hose fitted to a low volume vehicle must:

(a) *be of a type purposely designed for automotive applications; and*

(b) *incorporate a one-way check valve to prevent unintended loss of vacuum whilst the engine is not running; and*

(c) in the case of a hose that is not sourced from a high volume vehicle, meet one or more approved standards specified in Table 8.4. (see Table 8.4)

8.6.3

FMVSS 106 is the most common standard that an approved hose will comply with.

APPROVED STANDARD	ABBREVIATION
▪ Society of Automotive Engineers, SAE 40 R3L (light duty)	SAE 40 R3L
▪ Society of Automotive Engineers, SAE 40 R3H (heavy duty)	SAE 40 R3H
▪ Society of Automotive Engineers, SAE 40 M (heavy duty oil resistant)	SAE 40 M
▪ Society of Automotive Engineers, SAE J1403 (vacuum brake hose)	SAE J1403
▪ British Standard BSAU 109	BSAU 109
▪ Federal Motor Vehicle Safety Standard No. 106 (Brake hoses)	FMVSS 106 or DOT
▪ Japan Industrial Standard D2607	JIS D2607

Table 8.4 Vacuum brake hose approved standards table

8.7 Hydraulic brake pipe requirements

8.7.1

Hydraulic brake pipe fitted to a low volume vehicle must be:

(a) *of a type purposely designed for automotive applications; and*

(b) *manufactured from:*

(i) *steel bundy tubing; or*

(ii) *copper-nickel tubing.*

8.7.1(b)

Copper is considered by the industry as only being suitable for high corrosion applications such as boat trailers and stock trucks.

See the 'Useful Information' section at the back of this chapter for information on the use of stainless steel brake pipe.

A vehicle that was built or modified before 1992 that incorporates copper brake lines is not required to comply with 8.7.1(b), and may retain them, providing no sign of fatigue cracking is evident.

8.7.2

Hydraulic brake pipe fitted to a low volume vehicle must:

(a) *follow the shortest practical route; and*

(b) *be connected using double or ball flares; and*

(c) *be securely fastened to the vehicle structure at intervals:*

(i) *originally utilised by the vehicle manufacturer; or*

(ii) *no further apart than 300 mm (12").*

8.7.3

Hydraulic brake pipe fitted to a low volume vehicle must be mounted in such a position so as to be:

(a) *protected from being damaged by curbs, irregular road surfaces, or jacking equipment; and*

(b) *no closer than 100 mm (4") to any part of the vehicle's exhaust system, unless protected by a suitable heat-shield; and*

(c) *away from any moving components within the engine compartment; and*

(d) *able to be visually inspected without being removed; and*

(e) *protected from any chafing or abrasion where the hydraulic brake pipe passes through rigid sections.*

8.7.4

Hydraulic brake pipe which is mounted adjacent to any drive-shafts in a low volume vehicle that has been modified in such a way as to substantially increase power output, must either:

(a) *be re-directed away from the vicinity of the drive-shaft; or*

(b) *be protected from a drive-shaft failure by a 360-degree safety loop at each end of the drive-shaft, positioned within 150 mm (6") of each drive-shaft universal.*

8.7.5

Hydraulic brake pipe fitted to a low volume vehicle must not be electroplated, unless the electroplating is carried out as part of the manufacturing process by the brake pipe manufacturer.

8.7.2(b)

The low volume vehicle certifier, may, at his discretion, require the flares to be inspected, if he has reason to believe that they may not have been correctly flared.

8.7.2(c)

An approved alternative is for brake pipes to pass through a well-secured tubular section, known as a 'service tube', provided that the brake pipes are suitably supported, and cannot whip or flex.

8.7.3

This clause applies to scratch-built vehicles, or where the exhaust system or brake pipes have been changed or relocated.

8.7.3(b)

100 mm (4") is considered a minimum distance around headers, however this can reduce back to around 50 mm (2") further toward the rear of the system.

8.7.3(d)

Brake pipes may pass at 90 degrees through the width of a chassis rail or cross-member in order to run from one side of the vehicle to the other, but must not run lengthwise inside an enclosed chassis rail (eg RHS or boxed channel).

8.7.5

See note next page re electroplating.

8.8 Hydraulic brake hose requirements

8.8.1

A hydraulic brake hose fitted to a low volume vehicle must:

(a) *be of a type purposely designed for automotive applications; and*

(b) in the case of a hose that is not sourced from a high volume vehicle, meet one or more approved standards specified in Table 8.5. (see Table 8.5)

8.7.5

Electroplating is any process that involves 'electrolysis', which includes zinc, cadmium, gold, and silver. Stainless steel can be used if a high-quality finish is required, however it should be an annealed type, such as grade 304.

APPROVED STANDARD	ABBREVIATION
▪ Federal Motor Vehicle Safety Standard No. 106, (Brake hoses)	FMVSS 106 or DOT
▪ ISO 3996 (Brake hose assemblies for hydraulic braking systems used with non-petroleum-base brake fluid)	ISO 3996
▪ Society of Automotive Engineers, SAE J1401 (Hydraulic brake hose assemblies for use with non-petroleum-base hydraulic fluids)	SAE J1401
▪ Japanese Industrial Standard D2601 (Hydraulic Brake Hose for Automobiles)	JIS D2601
▪ Australian Design Rule 7/00 (Hydraulic Brake Hose)	ADR 7/00

Table 8.5 Hydraulic brake hose approved standards table (includes stainless-steel braided hoses)

8.8.2

Hydraulic brake hoses must not be used to replace rigid brake pipes on a low volume vehicle, except for where movement between vehicle parts makes this necessary.

8.8.3

Hydraulic brake hoses fitted to a low volume vehicle must be attached and located in such a way so as not to be able to:

(a) *come into contact with any moving parts such as wheels, tyres, brake or suspension components; and*

(b) *become caught or pinched between suspension spring coils, or the cover and body of the shock absorber.*

8.8.4

A hydraulic brake hose must be located and attached to a low volume vehicle in such a way that it is not fully extended, or under tension or excessive torsion at, or at any combination of, upward or downward suspension travel, or full steering lock.

8.8.1

Many aftermarket stainless-steel braided brake hoses don't comply with any approved standards for hydraulic brake hose, so be careful when purchasing them.

A 'high volume vehicle' is a production vehicle.

8.8.2

All brake pipes must, at the point where they connect to a brake hose, be rigidly supported.

8.9 Parking brake system requirements

8.9.1

A low volume vehicle, other than one of Class-LA, LB, LC, LD, or LE-1, must be fitted with a park brake system that operates on at least one axle.

8.9.2

A parking brake cable fitted to a low volume vehicle must be:

(a) *positioned or protected from being contacted by any moving parts of the vehicle; and*

(b) *securely fastened.*

8.9.3

A modification to a parking brake cable fitted to a low volume vehicle must be carried out by suitably experienced professionals, using components and attachment methods purposely designed for parking brake applications.

8.9.4

A low volume vehicle must not be fitted with a cardan-shaft parking brake system unless the vehicle is equipped with a dual circuit service brake system.

8.9.4 does not apply to a vehicle built, or fitted with a cardan-shaft parking brake system, before 1990.

8.9.5

A low volume vehicle, other than one for which an LVV Authority Card is issued that specifies 'Hydraulic hand-brake', must not be fitted with a hydraulically-operated parking brake system.

8.9.6

A parking brake lever assembly must be located and attached to a part of the structure of a low volume vehicle that is sufficiently strong to securely attach the parking brake lever assembly.

8.9.7

A parking brake lever fitted to a low volume vehicle must be able to be operated by the driver whilst in a normal seated position.

8.9.1

This is aimed particularly at Morgan-style 3-wheelers, which have one wheel at the back, which the park brake usually operates against.

A cardan-shaft park brake system is deemed to operate on one axle.

8.9.4

This means a vehicle built after 1 November 1990 with a single-circuit service brake system must have a parking brake that will bring the vehicle to a controlled stop if the service brake fails. This is because a cardan-shaft parking brake system is likely to be damaged if applied whilst the vehicle is moving. Also if the cardan-shaft is fitted to the back of the gearbox, damage could occur to the gearbox as a result of application of the parking brake at speed, causing drive and engine braking to be lost.

Note that any scratch-built vehicle built after 1 January 1992 must be fitted with a dual-circuit braking system.

8.9.5

MotorSport New Zealand's LVV Authority Card enables, amongst other things, for a hydraulic hand-brake to be fitted into a road-going motor-sport competition vehicle.

8.10 Anti-lock braking system requirements

8.10.1

A modified production low volume vehicle originally fitted by the vehicle manufacturer with an anti-lock braking system may be converted to a non anti-lock braking system, provided that:

(a) *the vehicle is provided with a warning label permanently positioned so as to alert the driver that the vehicle is no longer equipped with an ABS system; and*

(b) *the vehicle has any warning lights originally installed by the vehicle manufacturer to indicate the presence of an ABS system removed or de-activated; and*

(c) *all parts of the braking system which are unique to ABS are removed and either:*

(i) *replaced with the relevant parts from a non-ABS fitted variant of the same make and model; or*

(ii) *the system is modified to a non-ABS configuration using purpose-built braking components;*

and

(d) *documentation in a form specified by the Low Volume Vehicle Technical Association (Inc), verifies that 8.10.1(c) has been complied with.*

8.10.2

A scratch-built low volume vehicle incorporating an anti-lock braking system must utilise a complete system from one make and model of donor vehicle, installed in the same way as originally installed into the donor vehicle by the original vehicle manufacturer.

8.11 Electronic traction-control system requirements

8.11.1

A modified production low volume vehicle originally fitted by the vehicle manufacturer with a traction control system operated by computer-aided service brake application must:

(a) not have any components within the system replaced or altered beyond the original manufacturer's specifications; and

(b) if disabled, not affect in any way the continued safe operation of the main service braking system.

8.11.2

An electronic or computer operated traction control system that is fitted to a scratch-built low volume vehicle must be either:

(a) a complete system from one make and model of donor high volume vehicle, and fitted in the same way as the system was originally installed in the donor high volume vehicle by the manufacturer; or

(b) a reputable brand of aftermarket traction control system.

8.11.2

A 'high volume vehicle' is a production vehicle.

8.11.2(b)

An example of a known high-quality traction control system manufacturer is the UK/USA brand 'Racelogic'

8.12 Manual traction-control system requirements

8.12.1

A manually-controlled individual wheel brake system, if fitted to a low volume vehicle, must:

(a) not compromise the safety and reliability of the original service braking system's operation; and

(b) incorporate purpose-built automotive brake system components; and

(c) incorporate a warning light that is clearly visible to the driver when the system is operable; and

(d) incorporate operating levers that:

(i) return to a neutral position when released; and

(ii) have the facility to be temporarily enclosed or disabled to prevent use whilst the vehicle is being operated on public roads; and

(iii) are mounted in such a way that does not obstruct normal operation of the vehicle; and

(iv) meet the requirements specified for interior impact in 'Chapter 16 - Interior Equipment'.

8.12.1

These are systems typically used in 4WD competition events (sometimes referred to as 'fiddle brakes'), and are designed to enable extremely tight maneuvering.

8.12.2

A manually-controlled individual wheel brake system, if fitted to a low volume vehicle, must incorporate for each master cylinder, a mechanical means to prevent dislodgement of the master cylinder piston, by either:

(a) a solid mechanical stop fitted to the brake lever; or

(b) a securely attached plate positioned against the master cylinder piston.

8.12.2

Many of these systems rely on circlips and the machined grooves into which the circlips lock, to prevent dislodgement of the master cylinder piston, which on its own is not enough to reliably resist the hydraulic fluid pressure.

8.13 Roll control and line-lock requirements

8.13.1

A roll-control or line-lock device fitted to a low volume vehicle must:

(a) be a purpose-built automotive brake system component and use purpose-built automotive brake parts; and

(b) be electrically operated; and

(c) incorporate a warning light which is visible to the driver, that shows when the device is in use; and

(d) only be operable by a momentary switch that automatically disengages the device when the roll-control or line-lock device is released; and

(e) have the facility to be temporarily enclosed or disabled to prevent use whilst the vehicle is being operated on public roads.

8.13.1

These are devices primarily designed for drag racing applications, to facilitate front brake-only application, to enable static burn-outs.

8.14 Brake component attachment requirements

8.14.1

All fasteners incorporated in braking system attachment, modification, or adaptation within a low volume vehicle, must meet all requirements specified from 18.2 to 18.6 inclusive in 'Chapter 18 - Attachment Systems'.

8.14.2

The attachment of the pedal assembly, master cylinder, and servo to a low volume vehicle, must remain securely attached, with minimal deflection to its mounting structure, using a force applied to the pedal of approximately 90 kg (198 lb).

8.14.2

Minimal deflection is generally considered to be no more than would be expected in a production vehicle. 90 kg (198 lb) is about the amount of force a lightly built person could apply to a brake pedal in the event of a panic-stop situation.

8.15 Welding of braking system components

8.15.1

All welding incorporated in braking system attachment, modification, or adaptation within a low volume vehicle, must meet all requirements specified in 18.9 'critical function welding requirements' in 'Chapter 18 - Attachment Systems'.

8.16 Other technical requirements

8.16.1

A service braking system and a parking braking system fitted to a low volume vehicle must comply with the applicable performance requirements specified in 'Chapter 19 - Vehicle Operation'.

8.16.1

This braking performance evaluation process involves a multi-cycle service brake test, which ensures that the vehicle's braking system is suitably matched to the mass and performance potential of the vehicle.

General Requirements:

8.17 General safety requirements

8.17.1

A low volume vehicle must be fitted with a brake for each wheel.

8.17.2

All low volume vehicles must comply with the following general safety requirements:

(a) *a brake must be easily adjustable to compensate for wear and must be maintained in good condition and efficient working order; and*

(b) *the friction surfaces of a brake must be within safe tolerance of their state when manufactured and must not be scored, damaged or weakened to the extent that the safety performance of the brake is adversely affected; and*

(c) *the run-out and thickness of a brake or brake disc must be within the service limits set by the vehicle manufacturer, or the brake manufacturer, and if these are not known, the thickness must not be less than 90% of the original thickness; and*

(d) *if a vehicle is fitted with a warning system that is part of, or associated with, the use of a brake component or system, that warning system must function correctly.*

8.17.2

These general safety requirements are from the General Safety Requirements of the Land Transport Rule; Light Vehicle Brakes 2002 (Rule 32014). All vehicles, whether modified or standard, have to comply with these regulations.

8.17.2(c)

This means that you can't use discs or drums if they have been machined several times. If in doubt, compare the thickness against a new disc or drum for the same make and model of vehicle.

Exclusions:

8.18 Rod or cable braking system exclusions

8.18.1

A low volume vehicle that is constructed entirely of components and systems produced no later than 1952 is not required to comply with 8.4 to 8.8 inclusive, and may be fitted with a mechanical rod or cable braking system, provided that:

(a) the vehicle being constructed is a faithful and authentic reproduction of the vehicle being replicated; and

(b) the performance potential of the vehicle is not greater than the vehicle being replicated; and

(c) the cable or rod is of an appropriate diameter for its length and application; and

(d) the system incorporates a balancing or compensating mechanism between the front and rear axles to ensure that even braking is achieved; and

(e) in the case of a cable system, the cable is:

(i) in good condition and shows no signs of fraying or deterioration; and

(ii) is well secured;

and

(f) the vehicle can be stopped within a distance of 7 m (23′) from a speed of 30 kph (18 mph).

8.19 Two-wheeled braking system exclusions

8.19.1

A low volume vehicle that is constructed entirely of components and systems produced no later than 1927 is not required to comply with 8.17.1, and may be fitted with brakes that operate on two wheels, provided that:

(a) the vehicle being constructed is a faithful and authentic reproduction of the vehicle being replicated; and

(b) the performance potential of the vehicle being constructed is not greater than the vehicle being replicated; and

(c) the vehicle can be stopped within a distance of 7 (23′) from a speed of 30 kph (18 mph).

Useful Information:

Disc brakes

Disc brakes have generally proven to provide superior braking performance over drum brakes. For purely performance reasons, a disc brake system is preferable over a drum brake system, especially at the front of a vehicle, where, through weight transfer, the majority of the braking effect occurs. The larger diameter the disc, (providing everything else matches) the better the braking performance.

A ventilated disc brake rotor won't necessarily provide substantially better braking in a one-off stopping situation than a solid rotor of the same diameter, but it will improve multiple stopping performance, because of the fact that the ventilation designed into the disc allows better dissipation of the heat between brake applications.

Freshly skimmed, or machined discs with a good quality aftermarket brake pad, will provide a noticeable improvement in braking performance, especially under repeated applications.

Drum brakes

It is generally accepted that properly sized disc brakes will give more consistent and reliable fade-resistant braking than drum brakes, and are therefore a preferred option, particularly for front brakes. However, there are many applications where hobby car builders want to use drums for authenticity of appearance, when building something like a '40s or '50s era hot rods, or vintage and sports replicas and specials. Provided the drum system used is of adequate size and in good condition, drum brakes can still be very efficient, and the braking performance requirements can still be achieved.

A typical application would be a light to medium weight roadster with moderate power, say under 250 horsepower in 1135 kg (2500 lbs) or less, using a complete '39-'48 Ford hydraulic drum brake system. The cylinder will require an upgrade to a dual-circuit unit, but would not necessarily need boosting unless specifically required. Correct front to rear balance can be achieved as needed by using smaller rear wheel cylinders (or sleeving the standard cylinders down), or by using a proportioning valve.

Many other drum systems can be used, such as those found in 1950s Ford F100 pick-ups, but should always be as large as possible, with around 254 mm (10") as a minimum diameter.

Using the same donor vehicle to supply the stub axle, backing plate, and drum assembly will generally prove to be the simplest system to set up with the best end results.

Disc and drum selection based on vehicle weight and performance

There are two major factors to consider when selecting the discs and/or drums for a vehicle; weight, and performance potential. Here's an overview of both factors:

- Vehicle weight is the major influence on brake component selection, in particular the disc rotors and/or drums for both front and rear. Kinetic energy, which is basically the vehicle's forward motion energy, increases in direct proportion to the vehicle weight. For example, a light-weight 650 kg (1430 lb) Lotus 7 style special has around 233,000 Nm (172,000 ft lb) of kinetic energy to stop from 96 kph (60 mph), whereas a 2000 kg (4400 lb) big-block Chev Impala has around 718,000 Nm (530,000 ft lb) of kinetic energy to stop from 96 kph (60 mph). It doesn't take Einstein to figure that the Impala is going to need around 3 times the disc or drum braking power to get the vehicle weight stopped in the same time as the Lotus special.

- The other major influence on the braking component selection is the performance potential of the vehicle. Take a mid-sixties Chev Impala with a stock 283 and drive it hard over a road with a lot of corners, and the old drum brakes (providing they're in good condition) will probably do all you need of them. Now double the horsepower by bolting in a trick 400 small-block (same weight) and do the same drive, and you'll be experiencing a great big dose of brake fade in no time. The reason – the braking system now has less time to cool down between applications because the speed is reached in less time, not to mention that the increased acceleration has increased the speeds you're braking from. This is why the vehicle's performance potential has to be considered when selecting your braking components.

Use the brake component application table to help you work out what is going to do the right job for the weight and performance potential of your project vehicle.

Brake pads

Where a modified production low volume vehicle retains its factory equipped braking system, and has been modified in such a way as to increase the performance of the vehicle, high performance brake pads incorporating a relatively high metal content should be fitted.

Higher metal content within brake pads generally provides better heat dissipation and improved braking performance. Caution, though, is needed with your high performance brake pad selection; - don't go too far toward the highest (race-quality) metal-content pad, as these rely on several applications to build up sufficient heat for them to provide their optimum performance. This can be hazardous in an on-road situation – especially if the driver is not prepared for the poor braking performance provided by a high metal-content pad that is cold.

Pedal ratios

Pedal ratio is the relationship between the distances from the pedal pivot and the footplate, and the pedal pivot and the master cylinder. For example, a pedal that has 300 mm (12") between the pivot and the footplate, and 50 mm (2") between the pivot and the master cylinder, gives a pedal ratio of 6:1. The higher the pedal ratio, the more travel; the lower the pedal ratio, the less travel.

Master cylinders

In some applications when drum brakes are used all round, a residual pressure valve may be needed at the front of the master cylinder to provide some residual pressure against the wheel cylinders.

Where dual-circuit master cylinders are used in conjunction with non self-adjusting drum brakes, the master cylinder stroke should be checked with brakes fully de-adjusted to ensure that the master cylinder has sufficient stroke to prevent bottoming out.

This is because dual-circuit master cylinders sometimes have a shorter stroke than single-circuit master cylinders, and may not have sufficient stroke to prevent bottoming out if older drum brakes run out of adjustment.

Master cylinder bore diameter

The larger the bore diameter of a master cylinder, the less force it will apply to the system with the same amount of pedal force applied. If you want to increase the force to the system from the master cylinder, use a smaller master cylinder bore diameter. Generally, a lightweight hobby car can get sufficient braking force without a servo by using a 25 mm (1") or smaller master cylinder bore diameter.

Think of a 25 mm (1") diameter master cylinder applying 45 kg (100 lb) of force to a wheel cylinder or caliper;

- if the wheel cylinder is 12 mm (½") diameter, the resultant force out the other side will be 11 kg (25 lb);
- if the wheel cylinder is 25 mm (1") diameter, the resultant force out the other side will be 45 kg (100 lb);
- if the wheel cylinder is 50 mm (2") diameter, the resultant force out the other side will be 181 kg (400 lb). (see Diagram 8.3 Pedal pressures and cylinder forces)

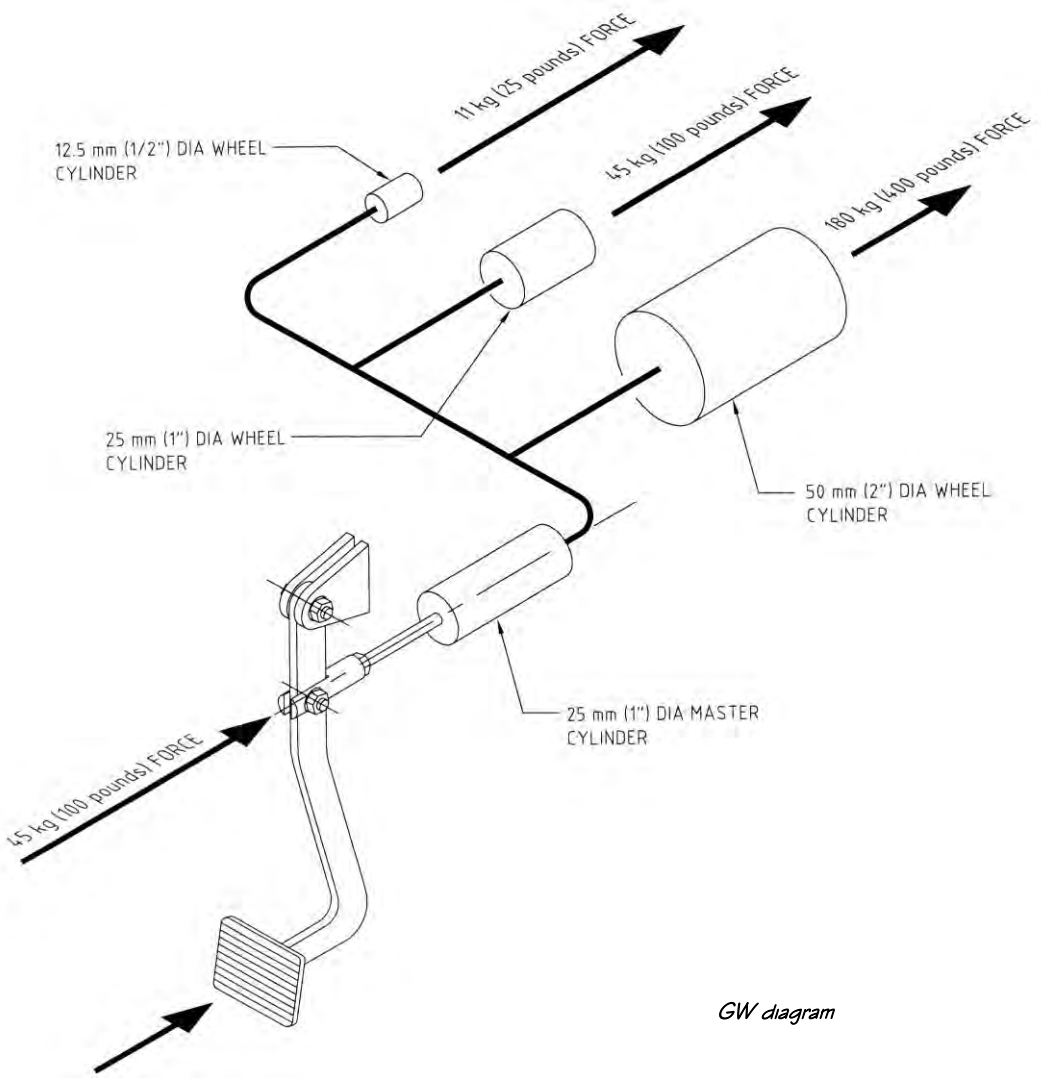


Diagram 8.3 Pedal pressures and cylinder forces

If you can't get enough pressure to all, or one end of your braking system, you can increase the pressure without changing your discs or drums by changing to either a:

- higher pedal ratio; or
- larger wheel cylinder or caliper piston diameter; or
- smaller master cylinder bore diameter.

A master cylinder with a small bore diameter gives a pedal that feels softer and travels further, and a master cylinder with a large bore diameter gives a pedal that feels harder and travels less.

The larger the tyre diameter, the greater the braking effort, and therefore the more pressure, that will be required.

Booster clearance problems

Limited under-floor room on some hobby cars can provide problems finding space for the booster if one is required. Because most hobby cars are relatively light, a nice compact 180 mm (7") booster off something like a 1970s Corolla will provide all the additional pressure needed, it will adapt well to a typical master cylinder like the HQ Holden type, and will solve your space problems.

Stainless steel brake pipe

The reason that stainless steel brake pipe is not listed in 8.7.1 as an approved material, is that because it is so hard, it isn't possible to create an approved double flare as can be achieved with steel bundy or copper-nickel material. However, it is recognised that the owners of some top-level show cars want to use stainless steel as a brake pipe material. Stainless steel may be used provided that the flaring of the pipe is carried out by a person who is professionally engaged in the car construction industry, and in whom the TAC has absolute confidence. The constructor or LVV Certifier should contact the TAC for specific advice if the owner proposes to use stainless steel brake pipe tubing.

Ford 9" disc brake adaptations on a budget

Disc brake adaptations can be carried out to a 9" Ford diff on a budget, by using the front calipers off an early front-wheel drive Subaru (with hand-brake mechanism incorporated) onto Toyota Hi-Ace rotors – the Hi-Ace rotors are a good size for the rear of even a relatively heavy vehicle, and have the bonus of incorporating the same stud pattern as the Ford.

Proportioning valves

Proportioning valves are often required to achieve the ideal balance between front to rear braking. The ideal situation is for the front brakes to lock up slightly before the rear – the opposite situation can be harder to control, particularly on a cambered surface or when steering is combined with the emergency braking.

Larger 'Pro-street' types of tyres, due to their larger road contact area, can be subject to aquaplaning on wet road surfaces, and therefore rear brake lock-up can occur before it would with the same braking system applied to 'normal' sized rear tyres. Therefore, take these types of tyres into account when planning and setting up your braking system, and incorporate a good compromise between the different effects of dry and wet road conditions.

Proportioning valves can be:

- fitted within the master cylinder; or
- stepped bore sizes for the two circuits within the master cylinder; or
- an independent proportioning valve positioned in the brake pipe between the master cylinder and the brakes.

Independent proportioning valves can be fixed, which means to constantly limit the pressure to one or other of the circuits, or they can be adjustable.

Adjustable proportioning valves are typically aftermarket items, and are usually fitted to the rear brake line to limit the pressure to the rear, as premature rear lock-up is the most common braking system imbalance. The pressure can be reduced by anywhere between 0 and 60%.

Setting up an adjustable proportioning valve can require a lot of brake testing (find some gravel or a wet surface to make life easier) to achieve the right balance, and sometimes a combination of a fixed proportioning valve and an adjustable proportioning valve is needed to get a system bang-on. Likely vehicle loading should be taken into account when setting up a proportioning valve, such as the number of seating positions available.

Be aware that even when using an entire OEM system from a production vehicle in a scratch-built hobby car, a braking imbalance could still result, requiring a proportioning valve to get it right. This is because other factors such as front to rear axle weight ratios, engine location, and rear tyre sizes, can all have an effect on braking bias.



TJ illustration

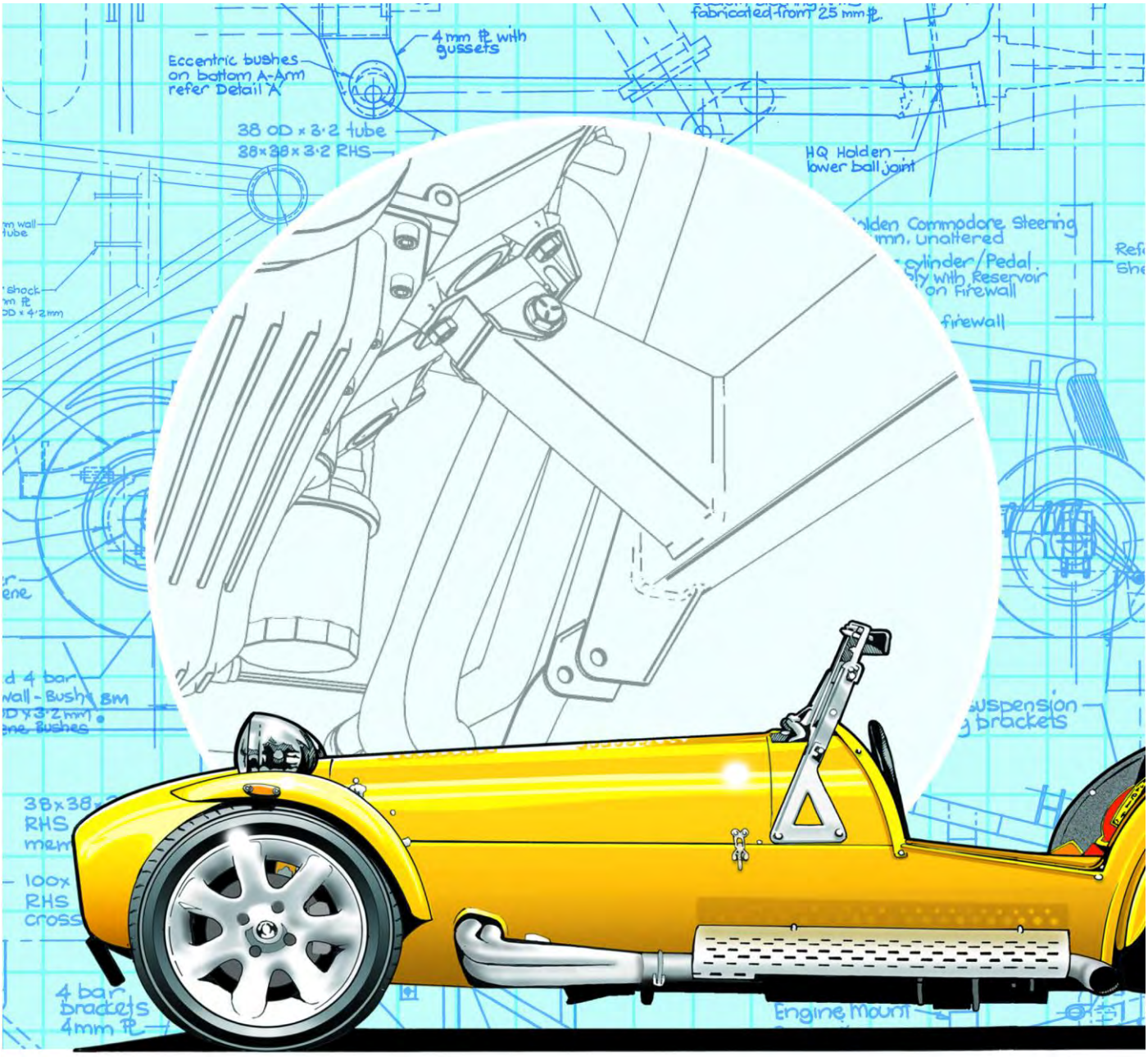
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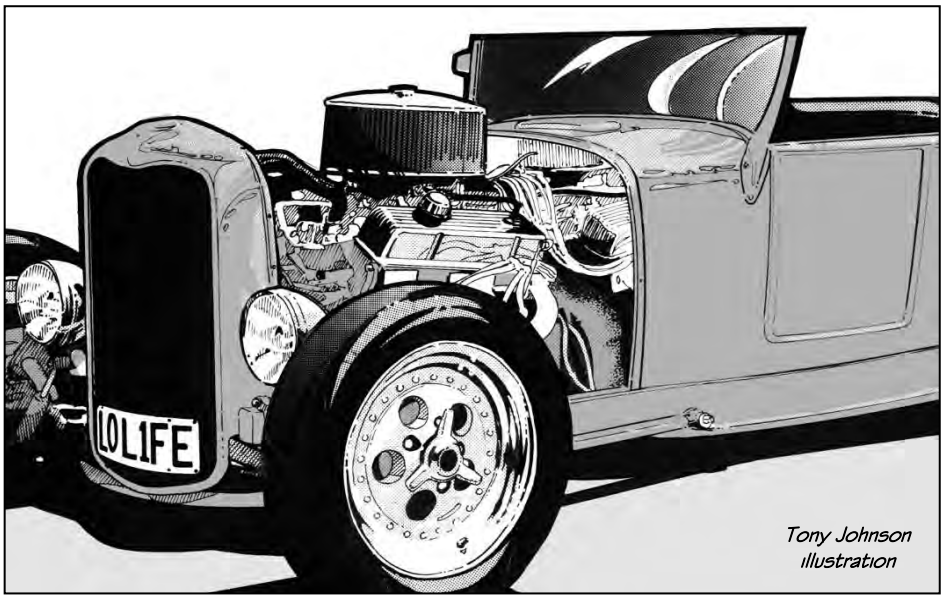
Chapter 9
Engine & Drive-train

3rd Amendment | Effective from 1 July 2021



Low Volume Vehicle Technical Association (inc)

Chapter 9
Engine & Drive-train



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The information in this NZ Car Construction Manual Chapter has stemmed from work undertaken by LVVTA founding member organisations that commenced prior to 1990 and has been progressively developed as an integral part of New Zealand Government safety rules and regulations by agreement and in consultation with the New Zealand Transport Agency.

As a result, the considerable experience in applied safety engineering built up by LVVTA and the specialist automotive groups over the past several decades can be of benefit to members of the New Zealand public who also wish to build or modify light motor vehicles.

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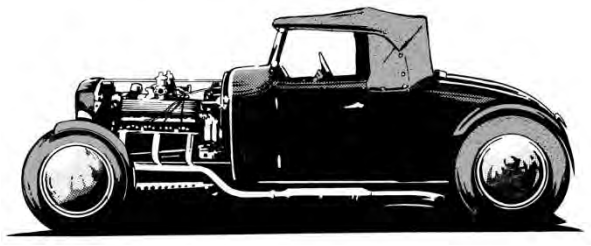
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Type Key: (For full details of Text Key, refer to Chapter 2 – About this Manual)

Normal type:	Provisions of the NZ Car Construction Manual for all vehicles.
Normal type in shaded box:	Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates.
Script type:	Helpful hints, tips, explanations, clarifications, and interpretations.
Grey shaded text & grey vertical stroke in margin:	Latest amendments since previous version. Note that text which is high-lit in grey shows amendments that have been made since the document's previous version, and a grey vertical stroke to the left of the text denotes new or changed information which is important (rather than just a grammatical, formatting, or numbering change).



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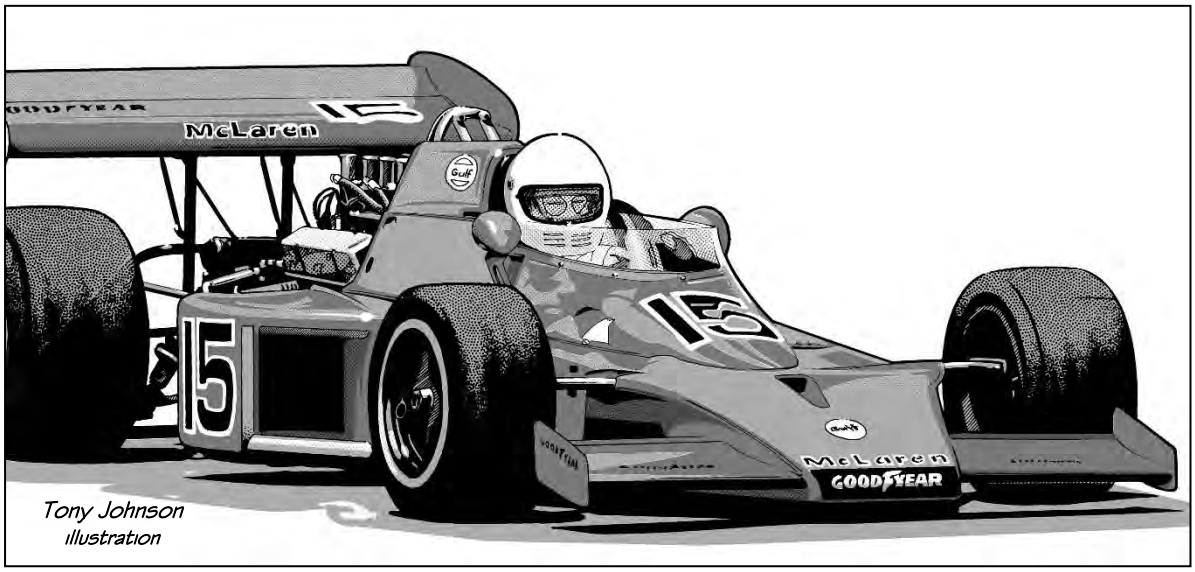
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Tony Johnson illustration

CHAPTER 9: ENGINE & DRIVE-TRAIN

Introduction:

The purpose of this Chapter is to specify sound practical engineering principles and procedures relating to the conversion of engines and drive-trains to motor vehicles, to ensure that such conversions are as safe as practicable, having regard to their effect on inter-related vehicle components and systems, especially those relating to braking and steering control.

The engine and drive-train is the heart and soul of any hobby car, and the installation and attachment of the engine and drive-train components is full of pitfalls for the unwary or inexperienced enthusiast. Getting this part right not only has safety pay-offs, but will improve your vehicle in terms of noise, vibration, and harshness, and perhaps best of all, will help the long-term reliability of your ride.

Note that where a production vehicle is fitted with its original un-modified engine and drive-train components in their original location, the requirements in this chapter do not apply.

General safety requirements:

9.0 Requirements applicable to all vehicles

9.0.1

A low volume vehicle must:

(a) be designed and constructed using materials and components that are fit for their purpose; and

(b) be safe to be operated on the road.

9.0.1

This is from 2.3 of Part 2 of the LVV Code, which makes it clear that, regardless of what technical requirements are or are not in place, every vehicle certified to the LVV Code must be fit for its purpose, and must be safe.

9.0.2

A steering system on a motor vehicle, and associated systems and components that could directly or indirectly affect the directional control of the vehicle, must:

(a) be sound and in good condition and must provide the vehicle with safe, efficient, convenient, and sensitive control; and

(b) be strong, durable and fit for its purpose, taking into account whether adverse effects have resulted from a loss of integrity of any protective system used by a relevant component.

9.0.2

These are the applicable general safety requirements from the Land Transport Rule 32003/1 Steering Systems 2001, which are required as part of this Chapter, reproduced here in the interest of convenience.

Engine conversion requirements:

9.1 Engine mount design and construction

9.1.1

An engine mount fitted to a low volume vehicle must be designed and constructed in such a way that:

(a) it is able to withstand all fore and aft, side, rotational, and vertical loads and dynamic forces that may be imposed on it, taking into consideration engine weight and torque output; and

(b) its design will not impair the life of the flexible mount by stress.

9.1.2

Where a north-south configured engine is fitted to a low volume vehicle, and solid-mounted front and rear engine plates are fitted instead of conventional rubber mounts:

(a) the plates must be designed and constructed in such a way that they are able to withstand all fore and aft, rotational, and up/downward loads imposed on them; and

(b) the gearbox, if attached to a gearbox cross-member or other part of the vehicle structure, should also be rubber-mounted.

9.1.2

See the 'Useful Information' section at the back of this chapter for some hints on solid-mounted engines and gearboxes.

9.1.3

An engine mount fitted to a low volume vehicle must be designed and constructed in such a way that upon failure of either one or both of the engine mounts, the engine weight could not cause the steering system to become jammed or affected by engine weight, which may include either:

(a) an engine mount chassis or sub-frame bracket designed to prevent the engine from dropping; or

(b) a safety-type engine mount that features a through-bolt that prevents detachment of the mount upon separation of the rubber from the backing plate; or

(c) an engine mount safety-strap.

9.1.4

An engine mount fitted to a low volume vehicle used to attach an engine positioned to the rear of the vehicle occupants, must be designed to minimise forward movement of the engine as much as practicable during a frontal crash.

9.1.5

Where a non-original or custom manufactured engine cross-member is installed on a low volume vehicle, the cross-member must be:

(a) designed and constructed so as to withstand:

(i) the weight of the engine and gearbox it supports; and

(ii) any rotational or other dynamic loads it may be subjected to;

and

(b) attached to chassis rails using all applicable requirements contained in section 5.4 of 'Chapter 5 – Chassis Modification & Construction'.

9.1.6

When engine mounting to a low volume vehicle necessitates bolting through a boxed, RHS, or tubular chassis or sub-frame section, fasteners must pass through steel tubular reinforcing within the chassis or sub-frame section to prevent crushing.

9.2 Engine positioning

9.2.1

Where a north-south configured engine is fitted to a low volume vehicle, the engine must be positioned in such a way that the crankshaft centre-line either:

(a) in the case of a modified production vehicle, duplicates as closely as possible the original engine crankshaft centre-line, ensuring that the drive-shaft universal angles of the new drive-train match the original as closely as possible; or

(b) in the case of a scratch-built vehicle, is correctly aligned with the drive-shaft and differential; or

(c) in the case of an engine and gearbox that has to be offset from the centerline of the chassis, is correctly aligned with the drive-shaft and differential.

9.2.2

The engine in a low volume vehicle must be mounted in such a way that when maximum engine torque is applied, it cannot come into contact with any part of the engine compartment, or items within the engine compartment.

9.2.3

An engine in a low volume vehicle which is positioned above a beam-type axle assembly must be mounted in such a way that adequate clearance is still available between the engine and the axle assembly, when the suspension is under full compression.

9.2.3

This is especially important for 4WD off-road vehicles which have a substantial amount of suspension travel, and are subject to rough treatment.

9.3 Engine attachment

9.3.1

A flexible mount used in an engine conversion or installation in a low volume vehicle must be of a type and size that will withstand all loads imposed on it.

9.3.2

Attachment of an engine mount to the engine, and an engine mount to the chassis or sub-frame section of a low volume vehicle, must either:

(a) in the case of a modified production vehicle, incorporate fasteners of a quantity, size, type, and grade of equal or greater specification than that used by the original engine manufacturer; or

(b) in the case of a scratch-built vehicle, incorporate fasteners of a quantity, size, type, and grade suitable for:

(i) the weight of the engine; and

(ii) the rotational or other dynamic loads the engine is capable of applying.

9.3.3

All fasteners used in the process of mounting an engine to a chassis or sub-frame of a low volume vehicle must meet all fastening requirements specified from 18.2 to 18.6 inclusive in 'Chapter 18 - Attachment Systems'.

9.4 Engine compartment and floor modifications

9.4.1

Any part of a firewall, floor, gearbox tunnel, or other structural section of a low volume vehicle that has been cut or removed to provide room for engine conversion clearance, must be adequately re-strengthened.

9.4.2

An engine cooling fan or other rotating component within an engine compartment of a low volume vehicle which could be easily contacted and cause injury, must, if such a component would normally be provided with protective covering by a high-volume vehicle manufacturer, be fitted with some form of protective cover to minimise the likelihood of contact.

9.4.3

All flexible hoses and wiring which extend from the body or chassis or sub-frame structure to the engine and gearbox of a low volume vehicle must incorporate sufficient slack to allow for full engine rotational or other movement on its mounts.

9.4.4

An opening between the engine compartment, floor, or transmission tunnel, and the passenger compartment of a low volume vehicle, must be sealed to prevent exhaust gases, vapour, and liquids from entering the passenger compartment.

9.5 Engine weight

9.5.1

A low volume vehicle fitted with an engine that is substantially heavier than the original engine, and is of a configuration never intended by the original vehicle manufacturer for fitment to the vehicle in question, must incorporate:

(a) where necessary, a means of preventing the chassis or sub-frame rails from spreading apart as a result of the additional weight or torque loading of the new engine; and

(b) suspension components, including springs and shock absorbers up-rated as necessary to support the additional weight of the new engine; and

(c) an engine cross-member beam, if fitted, that either:

(i) is strong enough to withstand the additional weight or torque loading of the new engine; or

9.5.1

Consideration should be given to ensuring that the vehicle manufacturer's Gross Vehicle Mass (GVM), or individual axle ratings, haven't been exceeded as a result of the fitment of a much heavier engine.

9.5.1(a)

This applies in particular to the more traditional engine conversions such as a cast-iron V8 into a Holden Torana or Ford Cortina.

(ii) has been reinforced to provide the necessary additional strength;

and

(d) an increase to the wheel hub assembly's load-carrying capability by having either:

(i) the hub assembly replaced with one which has an increased number of studs, or an increase to the pitch circle diameter; or

(ii) the original wheel studs replaced by studs of a diameter equivalent to a production vehicle that has a similar engine weight and number of wheel studs.

9.5.1(b)

While springs and shock absorbers are the obvious suspension items, consideration should also be given to stub axles, suspension arms, and any other load-bearing items.

Engine equipment and system requirements:

9.6 Superchargers & engine protrusions

9.6.1

An engine fitted to a low volume vehicle which incorporates exposed forward-facing moving components positioned above the line of the engine hood, that could be easily contacted and cause injury, such as a mechanical supercharger, must incorporate some form of protective covering to reduce the likelihood of contact.

9.6.2

An engine fitted to a low volume vehicle with protrusions extending beyond the line of the engine hood must comply with:

(a) the external projection requirements specified within 'Chapter 13 - Body Modification and Construction' to ensure against the presence of unnecessarily sharp forward-facing surfaces; and

(b) the visibility requirements specified within 'Chapter 15 - Glazing and Vision' to ensure against the presence of forward-facing obstructions.

9.6.2

See Chapters 13 and 15 to make sure that air-cleaners, hood scoops, or other engine components meet the external projection and sight-line requirements.

9.6.3

Unless authorised by an LVV Authority Card specified under Annex 5 of the Low Volume Vehicle Code, a low volume vehicle must be fitted with a functional engine hood so as to minimise the likelihood of additional injury to pedestrians through contact with engine components.

9.6.3

Traditional hot rods based on 1934 or earlier vehicles may be eligible for an LVV Authority Card to allow for period-style cars to operate without an engine hood, providing specified safety criteria are met.

9.7 Nitrous oxide systems

9.7.1

A nitrous oxide injection system fitted to an engine in a low volume vehicle must:

(a) incorporate hoses and fittings which are purpose-designed for automotive applications; and

(b) have all hoses routed outside the occupant cell, and be installed in such a way that gas from a leaking hose or fitting cannot escape into the passenger compartment; and

(c) be fitted with a fail-safe arming switch to prevent unintentional activation of the system.

9.7.2

A bottle used within a nitrous oxide injection system fitted to a low volume vehicle must:

(a) have a current test mark applied by the cylinder manufacturer or an approved cylinder test facility; and

(b) be securely mounted, either:

(i) outside the passenger compartment; or

(ii) if mounted inside the passenger compartment, sealed and vented to the outside of the vehicle;

and

(c) be specifically designed and manufactured:

(i) for the carriage of nitrous oxide; and

(ii) as a high-pressure vessel, incorporating a high-pressure safety blow-off valve.

9.7.2

Ideally, a vehicle using NOS should incorporate some form of prominent labeling similar to that used on LPG and CNG-equipped vehicles, to warn emergency services of the NOS's presence.

9.8 Fuel systems

9.8.1

A low volume vehicle must comply with the relevant fuel system requirements specified in 'Chapter 10 - Fuel Systems'.

9.8.2

A low volume vehicle fitted with an alternative fuel system, including liquid petroleum gas or compressed natural gas, must comply with the requirements of the approved New Zealand standard for alternative fuel systems.

9.9 Oiling systems

9.9.1

A system fitted to a low volume vehicle used for the circulation of hot fluids which operate under pressure must incorporate:

(a) purpose-designed bulkhead fittings and bulkhead connections where the fluid is being circulated through the inside of the passenger compartment; and

(b) hoses which:

(i) meet an appropriate standard for the type, pressure, and temperature range of the fluids being circulated; and

(ii) are secured at intervals of not more than 300 mm; and

(iii) are positioned and protected such that the hoses cannot rupture as a result of rubbing or chafing against any hard objects or sharp edges, or by damage from occupants or cargo.

9.9.1

Typical systems will include engine oil dry-sump hoses, and hoses used for the cooling of power steering systems and transmissions.

Particular care must be taken with hoses and fittings associated with oiling systems if a rupture could cause high temperature fluids to spray occupants.

9.10 Accelerator systems

9.10.1

An accelerator system on a low volume vehicle must:

(a) be designed so as to ensure against being pulled or jammed in the open position in the event of an engine mount failure; and

(b) in the case of a low volume vehicle incorporating a modified or custom-built accelerator system, be fitted with a minimum of two return springs that work independently of each other; and

(c) have linkages that:

(i) move freely and give good return response without interference from any other part of the vehicle; and

(ii) are designed and positioned in such a way that they cannot jam over-centre;

and

(d) have an effective end stop for the accelerator pedal to prevent cable stretch at maximum travel.

9.10.1

The accelerator return springs should connect directly to the carburetor(s) rather than the accelerator linkage system.

The accelerator system must be set up so that the carburetor(s) return to the closed position in the event of either the accelerator return springs or the linkages or cable breaking.

9.10.2

An accelerator system fitted to a low volume vehicle that is either hydraulically or electrically actuated, must be designed in such a way that the accelerator system, in the event of a loss of hydraulic pressure or electrical power, will fail to the fully closed position.

9.11 Exhaust systems

9.11.1

An exhaust system fitted to a low volume vehicle must:

(a) be of a good design using materials suitable for the purpose; and

(b) terminate in a position where the outer end of the exhaust pipe directs exhaust fumes and heat away from, and beyond the perimeter of, the passenger compartment; and

(c) in the case of an exposed exhaust system which may be easily contacted from outside the vehicle:

(i) have a radius of no less than 3 mm (1/8") on any sections facing toward the front of the vehicle; and

(ii) have any sections contactable from the front of the vehicle or adjacent to points of occupant entry and exit adequately heat-shielded.

9.11

'Flame-throwers' are an operational issue rather than an LVV certification issue. Whilst they are not required to be considered as part of the LVV certification process, LVVTA recommends against their use.

9.11.1(c)(i)

This means that no exposed exhaust ends or openings may face forward toward the front of a vehicle.

9.11.2

An exhaust system fitted to a low volume vehicle must:

(a) be in good condition and free of leaks; and

(b) be securely attached to the vehicle, using a mounting system that enables all necessary engine movement without stressing the exhaust system; and

(c) along with the body of a low volume vehicle in the areas adjacent to the vehicle's exhaust system, be sufficiently sealed so as to prevent the entry of any exhaust gases into the passenger compartment, and

(d) be designed, constructed, and fitted in such a way that the exhaust system, or components within the exhaust system, cannot be removed, altered, or readily interfered with, without the use of hand tools; and

9.11.2(e)

Exhaust noise output is an operational issue, and not a safety one, however an LVV certifier should ensure that a vehicle undergoing low volume vehicle certification has an exhaust system that meets Warrant of Fitness requirements, and that provides sufficient silencing so as to prevent the emission of exhaust noise levels that are likely to be alarming to residents, pedestrians, and other road users.

(e) be designed in such a way that the performance or operation of the exhaust system cannot be altered from inside the vehicle, or whilst the vehicle is in motion, unless the exhaust noise output is less than or similar to the noise output the vehicle (or a vehicle of a similar type) would have had when it was manufactured with its original exhaust system.

9.11.2(e)

A vehicle of a 'similar type' means a vehicle of similar age, vehicle size, body type, engine size and power output, and may be of a different make and model.

For information and legal requirements relating to exhaust noise output, refer to 'Chapter 11 – Emissions Systems'.

9.11.3

A component fitted to a low volume vehicle which may be susceptible to damage from exhaust heat, such as a fuel or brake pipe or hose, or rubber or fabric steering component, or plastic fuel tank, must either:

(a) be protected from any exhaust heat by the inter-positioning of a suitably fabricated and mounted heat-shield; or

(b) be provided with no less clearance from the exhaust system than that designed by the vehicle manufacturer; or

(c) be positioned so that there is a minimum clearance between the component and the exhaust system of:

(i) in the case of any part of the exhaust system other than a catalytic converter, 50 mm; or

(ii) in the case of a catalytic converter, 100 mm.

9.11.4

While a steel steering universal joint will not normally be damaged by exhaust heat, the grease contained inside the universal joint will be affected if there is not sufficient clearance between the joint and the exhaust, and this could prevent smooth steering joint operation.

9.11.4

A steel steering universal joint fitted to a low volume vehicle must be positioned so that there is a minimum clearance between the universal joint and any part of the exhaust system of 25 mm.

9.12 Braking systems

9.12.1

A low volume vehicle that has undergone an engine conversion that results in braking system modifications, or that may affect the performance of the braking system, must comply with the applicable requirements contained in the relevant braking design and construction requirements specified in 'Chapter 8 - Braking Systems'.

9.12.1

The braking performance of a vehicle may need to be improved in situations where the vehicle's performance has increased as a result of engine modifications or an engine conversion, in order to provide the braking efficiency necessary for the vehicle's increased performance. This is because of the reduced 'cool-down' time available to the vehicle's braking components between braking cycles resulting from the vehicle's increased performance.

9.13 Vacuum systems

9.13.1

A low volume vehicle that has been fitted with an engine which draws its vacuum from an alternator-mounted pump must have an alternator and drive system that:

(a) enables correct operation of the vacuum pump; and

(b) has correctly aligned drive pulleys; and

(c) incorporates drive-belts which are:

(i) in good condition; and

(ii) correctly adjusted; and

(iii) of the correct section type and width for the pulleys; and

(iv) of a purpose-designed heat and oil-resistant automotive type.

9.13.1

Vacuum hoses must be an approved type, as specified in section 8.6 of Chapter 8 – Braking Systems.

9.14 Electrical systems

9.14.1

A battery fitted to a low volume vehicle must:

(a) be secured by, or enclosed in, a device or structure, appropriate for the weight and load of the battery being used, to prevent it from shifting during braking, cornering, acceleration, or impact; and

(b) incorporate some method of preventing acid spills from entering the passenger compartment of the vehicle during a roll-over; and

(c) be sealed from the passenger compartment, and where charging and subsequent gas emission may occur while the vehicle is operating, ventilated to the vehicle exterior; and

(d) be safely wired and protected from short circuits.

9.14.1

Even if enclosed, a battery must not be able to move within the enclosure. If the enclosure is larger in any direction than the battery, the battery must also be secured.

Note also, that if a battery is secured within an enclosed container, provision must be made for the venting of the battery.

9.14.2

Where a battery, and fuel system components, such as a fuel tank or fuel pump, are located within the same compartment in a low volume vehicle, the battery and the fuel system components must be separated from each other by the enclosure of one or both within a secured fuel-resistant non-conductive container.

9.14.2

A motor-sport 'battery box' is ideal in this situation.

9.14.3

An earth lead of a size suitable for the application must be fitted to a low volume vehicle:

(a) in the case of a unitary construction vehicle, between the engine and body; and

(b) in the case of a vehicle with a separate body and chassis, between:

(i) the engine and chassis; and

(ii) the body and chassis.

9.14.4

Electrical wiring within the engine compartment of a low volume vehicle must:

(a) be tidily clipped and securely attached to the body or chassis or sub-frame structure; and

(b) positioned at a safe distance away from moving parts and exhaust heat.

9.14.4(a)

An approved alternative is for electrical wiring to pass through a well-secured tubular section, known as a 'service tube', provided that the wiring is suitably supported, and cannot rub or chafe.

9.14.5

Unless specifically designed for the purpose and fitment, an electrical system within a low volume vehicle must have electrical equipment such as pump motors and solenoids isolated from the fuel tank and system.

9.15 Steering system modifications

9.15.1

Where an engine conversion in a low volume vehicle results in the power steering system fitted to the vehicle being driven by a different means than that provided by the vehicle manufacturer, the pressure and supply delivery provided by the new engine or delivery system must be sufficient to safely operate the power steering system.

9.15.2

A low volume vehicle that has undergone an engine conversion that results in steering system modifications other than that specified in 9.15.1, or that may affect the performance of the steering system, must comply with the applicable requirements contained in 'Chapter 7 - Steering Systems'.

Gearbox conversion requirements:

It should be noted that there is no legal requirement in New Zealand for a motor vehicle to have a reverse gear. Caution should be applied here however if any motor sport activities are planned; a reverse gear is required for most motor sport classes.

9.16 Gearbox mount design and construction

9.16.1

Where a non-original or custom manufactured gearbox mount or cross-member is installed into a low volume vehicle, the cross-member must be:

(a) designed and constructed so as to withstand:

(i) the weight of the gearbox it supports; and

(ii) any rotational or other dynamic loads it may be subjected to;

and

(b) attached to chassis rails using all applicable requirements contained in section 5.4 of 'Chapter 5 – Chassis Modification & Construction'.

9.17 Gearbox attachment

9.17.1

9.17.1

See 5.20.2 of 'Chapter 5 - Chassis Modification and Construction' for details on correct crush-tube systems.

When gearbox mounting to a low volume vehicle necessitates bolting through a boxed, RHS, or tubular chassis or sub-frame section, fasteners must pass through steel tubular reinforcing within the chassis or sub-frame section to prevent crushing.

9.17.2

A flexible mount used within a gearbox conversion or installation in a low volume vehicle must be of a type and size that will withstand all loads imposed on it.

9.17.3

Attachment of a gearbox to a gearbox mount, a gearbox mount to a gearbox cross-member, and a gearbox cross-member to the chassis or sub-frame section of a low volume vehicle, if bolted, must:

(a) in the case of a modified production vehicle, incorporate fasteners of a quantity, size, type, and grade of equal or greater specification than that used by the original engine manufacturer; or

(b) in the case of a scratch-built vehicle, incorporate fasteners of a quantity, size, type, and grade suitable for:

(i) the weight of the gearbox; and

(ii) the rotational or other dynamic loads the engine is capable of applying.

9.17.4

A fastener used in the process of mounting a gearbox to a chassis or sub-frame of a low volume vehicle must meet all fastening requirements specified in 18.2 to 18.6 inclusive in 'Chapter 18 - Attachment Systems'.

9.18 Other gearbox requirements

9.18.1

Any part of a unitary-constructed low volume vehicle that has had any part of its chassis or subframe structure, floor, or gearbox tunnel material cut or removed for clearance or shifter installation, must be adequately re-strengthened.

9.18.2

A gear-shift mechanism in a low volume vehicle must:

(a) operate easily, smoothly, correctly, and logically; and

(b) operate without any binding, or interference caused by the shift mechanism touching any other components or part of the vehicle structure; and

(c) in the case of an automatic transmission, provide to the driver a visible and accurate indication of the selected gear; and

(d) be sealed, where the mechanism enters the passenger compartment, to prevent the entry of fumes.

9.18.2(c)

A proper device is required to show the selected gear position to the driver. Note that a gear pattern indicator (such as that typically engraved into a gear knob) is not sufficient in the case of an automatic transmission, as it does not indicate the gear that has been selected.

9.18.3

A low volume vehicle fitted with an automatic transmission must incorporate an operative inhibitor switch, to enable engine starting only in neutral and park positions.

Drive-shaft requirements:

9.19 Drive-shaft modification and construction

9.19.1

A drive-shaft fitted to a low volume vehicle must be manufactured from:

(a) tubing of a material specification appropriate for a drive-shaft; and

(b) of a diameter and wall thickness appropriate for the power, torque, and weight of the vehicle.

9.19.1

When replacing a 2-piece drive-shaft system with a single drive-shaft, the new longer drive-shaft must be made from tubing that has a significantly greater strength than the tubing from which the two shorter drive-shafts are made from.

9.19.2

A drive-shaft fitted to a low volume vehicle may be lengthened only if:

(a) either:

(i) the complete original drive-shaft tube is replaced by a complete new single piece of tubing, without any spigots or joined sections; or

(ii) where the drive-shaft yoke and drive-shaft tubing are of different diameters, a purpose-designed and manufactured concentric adapter (reducing or increasing bush) is used to adapt the drive-shaft yoke to the tubing;

and

(b) the main tubing material thickness is not reduced during any machining processes that are carried out; and

(c) in the case of a substantial increase in drive-shaft length or engine power output, the diameter of the drive-shaft is increased proportionately with the drive-shaft length or engine power output.

A drive-shaft lengthened before September 2002 is not required to comply with 9.19.2, provided that after thorough visual inspection, no fatigue cracking or fracturing is evident, and no obvious vibrations are detected during a road-test.

9.19.3

A modified, custom-manufactured, or non-original equipment drive-shaft fitted to a low volume vehicle must be manufactured or modified by a person or manufacturer who is a recognised industry specialist in the field of drive-shaft modification and manufacture.

9.19.4

In the case where it cannot be determined that a modified, custom-manufactured, or non-original equipment drive-shaft fitted to a low volume vehicle has been manufactured or modified by a person or manufacturer who is a recognised industry specialist in the field of drive-shaft modification and manufacture as required by 9.19.2, then the drive-shaft must either:

(a) be visually inspected and dynamically balanced by a person who is a recognised industry specialist in the field of drive-shaft modification and manufacture; or

(b) be assessed by an LVV Certifier and found to be satisfactory as a result of:

(i) a thorough visual inspection which has determined that the drive-shaft has no visible damage or defects, and has been built to a tradesman-like standard; and

9.19.2

The intention of these requirements is to prevent people from lengthening a drive-shaft tube with the addition of a welded extension, rather than using a correct length section of tubing.

A purpose-designed and manufactured concentric adaptor (reducing or increasing bush) is a recognised method only in the case where the diameters of the drive-shaft yoke and drive-shaft tubing differ.

9.19.4

Examples of situations where 9.19.4 would apply are:

- where a modified or custom-manufactured drive-shaft is fitted to a vehicle that has been imported from overseas, and for which no information about the drive-shaft exists; or
- where an LVV Certifier is inspecting a vehicle for recent modifications to which a modified or custom-manufactured drive-shaft was fitted some years previous to the recent modifications which have caused the vehicle to require LVV certification.

(ii) driving the vehicle during a 100 kph road-test and determining that there is an absence of any harmonic vibration from the drive-shaft.

9.19.5

A drive-shaft fitted to a low volume vehicle must maintain the majority of its drive-shaft yoke coupling depth engaged into the gearbox output shaft throughout the full range of suspension travel.

9.19.6

A drive-shaft fitted to a low volume vehicle may be fitted with a drive-shaft spacer between the drive-shaft and the differential flange, in order to increase the overall length of the drive-shaft, provided that:

(a) the spacer:

(i) is no more than 25 mm in thickness; and

(ii) is manufactured from a solid piece of suitable material; and

(iii) incorporates a correctly-machined hub-centric spigot which replicates the engagement of the original unmodified drive-shaft components;

and

(b) the vehicle to which the spacer is fitted has not undergone a significant power or torque increase.

9.20 Drive-shaft attachment

9.20.1

A drive-shaft fitted to a low volume vehicle must be attached such that interference is unlikely to occur between the underside of the body or any other components during full suspension travel.

9.20.2

Fasteners used in the attachment of a drive-shaft to a low volume vehicle must:

(a) in the case of a modified production vehicle, be of a quantity, size, type, and grade of equal or greater specification than that used by the original engine manufacturer; or

(b) in the case of a scratch-built vehicle, be of a quantity, size, type, and grade suitable for:

9.19.4

Where an LVV Certifier has any doubts or concerns during his assessment process in 9.19.4(b), he should refer the drive-shaft for an expert assessment as provided for in 9.19.4(a).

9.19.6

A drive-shaft spacer is sometimes used to correct a safety-related problem of insufficient spline engagement, which can occur as a result of raising the suspension system of a vehicle, commonly encountered in raised four-wheel drive vehicles.

(i) the weight of the drive-shaft; and

(ii) the loads the engine torque is capable of applying;

and

(c) where fasteners are not original equipment for the drive-shaft or the vehicle, meet all requirements specified in 18.2 to 18.6 inclusive in 'Chapter 18 - Attachment Systems'.

9.21 Drive-shaft universals

9.21.1

A drive-shaft universal fitted to a low volume vehicle must:

(a) be of a size appropriate for the torque loads that the engine is capable of applying; and

(b) not be able to bind throughout the full range of suspension travel; and

(c) be aligned in such a way as to not induce premature wear or cause vibration; and

(d) operate at angles that are within the universal manufacturer's specifications; and

(e) if not original universals in the original application, operate at a minimum of three degrees angle to prevent brinelling; and

(f) be positioned so that all universal angles and phasing are in alignment, unless exact factory misalignment is duplicated.

Drive-shaft safety-loop requirements:

9.22 When drive-shaft safety-loops are required

9.22.1

Unless 9.22.2 or 9.22.3 applies, a drive-shaft safety-loop must be fitted at the forward end of each section of drive-shaft transmitting power to the rear wheels on any low volume vehicle which is of a front-engine and either rear-wheel drive or four-wheel drive configuration, and which incorporates an open drive-line, if:

(a) the vehicle has had an engine conversion which has resulted in a significant increase in power or torque; or

(b) the vehicle has had its factory-fitted engine modified such that a significant increase in power or torque has resulted; or

9.21.1

These requirements relate to 'hooks' type joints used in front-engine rear-drive vehicles.

9.21.1(a)

For example, a 6-cylinder Ford falcon front yoke and universal joint will fit straight into many high-performance V8 conversions, but will not be up to the task expected of it.

9.21.1(d)

Generally, drive-shaft manufacturers recommend angles of not less than 1 degree, and not more than 5 degrees. Even when a drive-shaft safety-loop is fitted, 5 degrees should not be greatly exceeded.

9.21.1(f)

Universal phasing is a complex area, and often misunderstood even by many experienced car builders, which is one of the reasons it is a requirement to use an experienced drive-shaft specialist to make your drive-shaft.

9.22.1

Where a vehicle is required to have a drive-shaft safety-loop, and the vehicle has a two or three-piece drive-shaft, a drive-shaft safety-loop must be fitted to each drive-shaft section.

9.22.1(a) and (b)

A 'significant increase' in power or torque is 50%.

(c) the drive-shaft fitted to the vehicle, either:

(i) has been modified by welding; or

(ii) is an aftermarket drive-shaft, including one made from steel, carbon-fibre, aluminium, or a composite material.

See the 'Useful Information' section at the back of this chapter for further explanation on the importance of using drive-shaft safety-loops.

9.22.2

9.22.2

Provided that all drive-shaft components are identical between the variants of the vehicle, the requirements specified for a low volume vehicle to be fitted with a drive-shaft safety-loop in 9.22.1 do not apply where either:

Documented evidence must be provided by the vehicle manufacturer or the vehicle manufacturer's agent to verify that all drive-shaft components are identical between the variants of the make and model of vehicle.

(a) a same make and model variant engine conversion has occurred; or

(b) a same make and model variant turbocharger or supercharger conversion has occurred.

9.22.3

The requirements specified in 9.22.1 for a low volume vehicle to be fitted with a drive-shaft safety-loop do not apply where either:

(a) a drive-shaft hanger bearing is positioned directly behind a drive-shaft universal, and the hanger bearing is designed in such a way that it will effectively contain a failed or disengaged drive-shaft; or

(b) a chassis or sub-frame member or section is positioned in such a way that it meets or exceeds the requirements for a drive-shaft safety-loop specified in 9.23 to 9.26.

9.23 Drive-shaft safety-loop design and construction

9.23.1

9.23(1)(c)(i)

Commercially-manufactured drive-shaft safety-loops are typically made from 5 mm thick flat-section material.

A drive-shaft safety-loop fitted to a low volume vehicle must:

(a) be as close to circular in shape as practicable; and

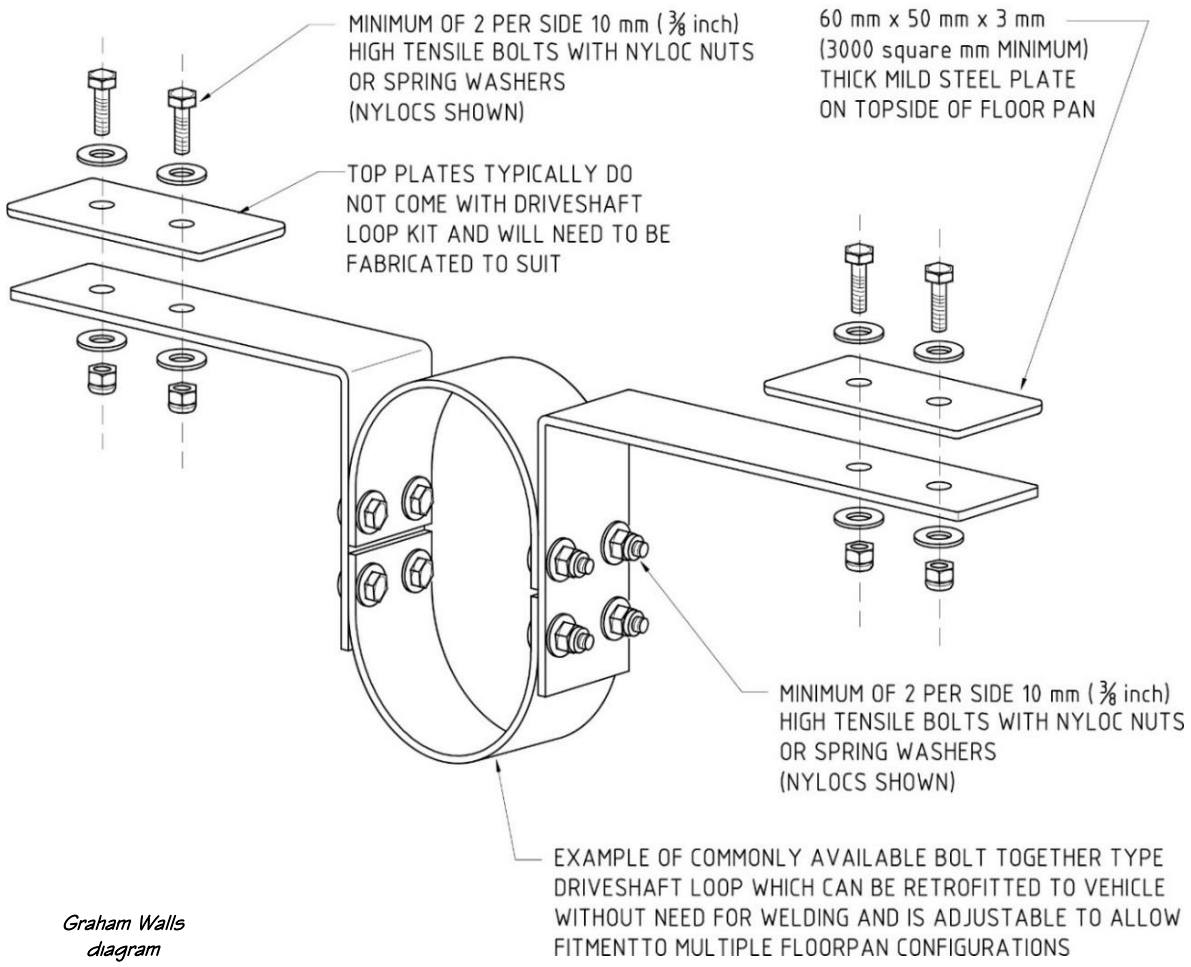
(b) provide a full 360-degree enclosure of the drive-shaft (see Diagrams 7.1 and 7.2); and

(c) be manufactured from a suitable material with a specification of, or equivalent to, not less than:

(i) in the case of flat-section material, 50 mm x 5 mm mild steel; or

(ii) in the case of tubular-section material, 22 mm x 3 mm mild steel.

If using a flat-section material, the 5 mm thick face of a 50 x 5 mm safety-loop must not face the drive-shaft, as the edge of the safety-loop could, upon contact, behave like a parting tool and cause a drive-shaft failure.



Graham Walls diagram

Diagram 7.1: Commonly-available bolt-together drive-shaft safety-loop

9.24 Drive-shaft safety-loop positioning

9.24.1

A drive-shaft safety-loop fitted to a low volume vehicle must be positioned:

(a) no more than 250 mm rearward of the front drive-shaft joint pivot centre; and

(b) as closely to the drive-shaft as can be practicably achieved, whilst taking into consideration:

(i) the drive-shaft's full range of articulation; and

(ii) the vehicle's range of suspension travel from full compression to full extension.

9.25.1(b)

Keeping the 'loop' section as close as practicable to the vehicle structure will prevent the safety-loop from pivoting forward or backwards, or from deflecting in any direction.

9.25.1(b)

Where the 'loop' section can't be positioned closely to the vehicle structure, additional support may be required to eliminate flexing or deflection of the loop.

9.25 Drive-shaft safety-loop attachment

9.25.1

A drive-shaft safety-loop fitted to a low volume vehicle must be attached to the vehicle structure:

(a) in not less than two places; and

(b) as closely to the 'loop' section of the drive-shaft safety-loop as practicably achievable (see Diagrams 7.1 and 7.2).

9.25.2

A drive-shaft safety-loop fitted to a low volume vehicle must either:

(a) be attached directly to, or incorporated within, a chassis or sub-frame rail or rigid cross-member, using, on each side of the drive-shaft safety-loop, two 10 mm (3/8") diameter fasteners, or one 14 mm (9/16") diameter fastener, of an appropriate grade; or

(b) where it is not practicable to attach a drive-shaft safety-loop to a chassis or sub-frame rail or rigid cross-member, be attached to the vehicle floor on each side of the drive-shaft safety-loop using:

(i) top plates mounted on top of the floor which are shaped as closely to square as can be practicably achieved, and which have a minimum mating area of 3000 square mm; and

(ii) two 10 mm (3/8") diameter adequately-spaced fasteners of an appropriate grade on each side of the drive-shaft safety-loop.

9.25.3

All top plates used in the attachment of a drive-shaft safety-loop to a low volume vehicle must:

(a) be oriented as closely as practicable to parallel to the longitudinal centreline of the vehicle; and

(b) have all corners rounded to a radius of not less than 5 mm (3/16"); and

(c) have all edges which contact the vehicle structure to which the top plate attaches rounded by the removal of not less than 0.1 mm of material.

2.25.2(a) and (b)(ii)

Refer to Chapter 18 – Attachment Systems for further information about fasteners.

2.25.2(b)(i)

The reference to 'as closely to square as can be practicably achieved' means that a top plate should, while achieving a total surface area of not less than 3000 square mm, be more 'square' than 'rectangular'. For example, a 60 mm x 50 mm top plate is closer to 'square' than a 100 mm x 30 mm plate, even though they both provide the same surface area.

9.25.3(a)

The reference to 'parallel to the longitudinal centreline of the vehicle' means that top plates should be oriented such that, when looking down on the vehicle floor from above, the plates are arranged in a 'square' or 'rectangular' shape rather than a 'diamond' shape. This orientation arrangement reduces the chances of impacts against the floor (caused by a failed or disengaged drive-shaft flailing within a drive-shaft safety-loop) being applied by the corners of the top plate, and creating a point-load, leading to tearing and failure of the floor.

9.25.3

When a top plate is used together with an under-floor plate, it is recommended that they be riveted together.

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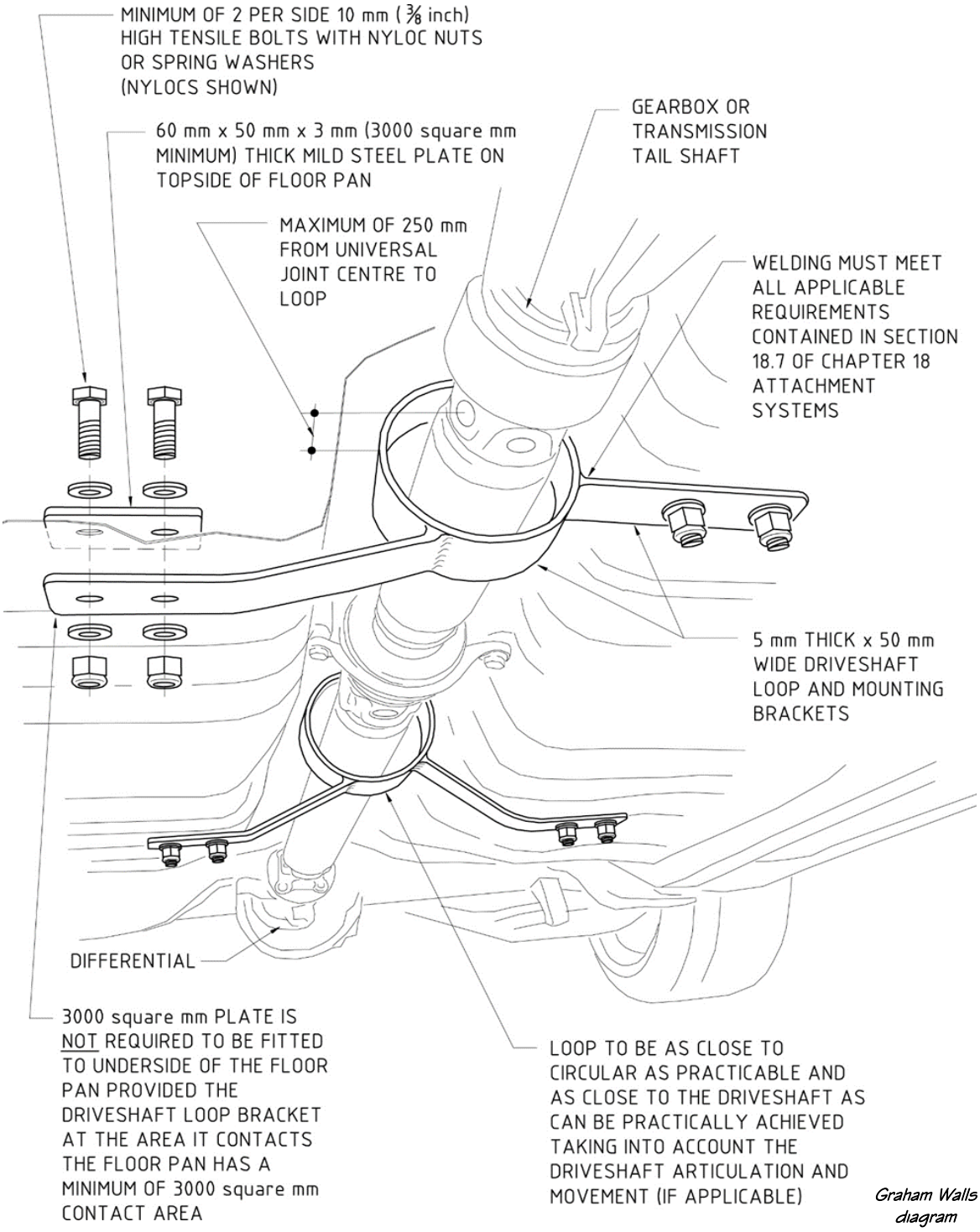


Diagram 7.2 Typical drive-shaft safety-loop installation

9.25.4

Where the mounting surface area of a drive-shaft safety-loop fitted to a low volume vehicle is less than 3000 square mm, an additional under-floor plate must be fitted to the underside of the floor (see Diagram 7.2).

9.25.4

A typical plate size that meets the 3000 square mm requirement is 50 x 60 x 3 mm.

9.25.5

The mounting surface area on the floor of a low volume vehicle to which a top or under-floor plate is attached, must be free from any compressible material, in order to enable the plate to seat firmly against the floor.

9.25.5

It is not necessary to remove thin, spray-on type coatings, such as underseal material, from the underside of the floor-pan beneath the plate or safety-loop surface.

9.26 Other drive-shaft safety-loop requirements

9.26.1

Where a hydraulic brake pipe fitted to a low volume vehicle is mounted adjacent to a drive-shaft which is required to be protected by a drive-shaft safety-loop, either:

(a) the drive-shaft safety-loop must be designed and attached so as to prevent the drive-shaft, upon its failure, from contacting the hydraulic brake pipe; or

(b) the hydraulic brake pipe must be re-directed away from the vicinity of the drive-shaft.

Axle housing requirements:

9.27 Axle housing and differential modification

9.27.1

Where an axle housing assembly conversion has taken place on a low volume vehicle, either:

(a) the vehicle's original suspension geometry and suspension locating mounting points must be duplicated on the replacement axle housing assembly, and at the chassis or sub-frame attachment points; or

(b) in the case of a changed suspension system configuration, the suspension must meet the relevant requirements specified in 'Chapter 6 - Suspension Systems'.

9.27.2

A differential fitted to a low volume vehicle must not be fitted with a permanently locked diff centre, spool, or mini-spool.

9.27.3

A differential fitted to a low volume vehicle that is of a type that, upon failure of an axle could result in the loss of a wheel, must be fitted with axles that are appropriate for the torque loads that the engine is capable of applying.

9.28 Axle housing attachment

9.28.1

Fasteners used in the attachment of an axle housing assembly to a low volume vehicle, must either:

(a) in the case of a modified production vehicle, be of a quantity, size, type, and grade of equal or greater specification than that used by the original differential manufacturer; or

(b) in the case of a scratch-built vehicle, be of a quantity, size, type, and grade suitable for:

(i) the weight of the differential; and

(ii) the loads the engine torque is capable of applying; and

(iii) if not original equipment for the axle housing or the vehicle, meet all fastening requirements specified from 18.2 to 18.6 inclusive in 'Chapter 18 - Attachment Systems'.

Other requirements:

9.29 Welding of drive-train components

9.29.1

Welding of any engine mounts, gearbox mounts or cross-members, differential housing modifications, or drive-shaft safety-loops on a low volume vehicle, must meet all relevant welding requirements specified in 18.7 and 18.8 of 'Chapter 18 - Attachment Systems'.

A drive-train component fitted to a low volume vehicle and modified before September 2002 is not required to comply with 9.29.1, provided that after thorough inspection, no fatigue cracking or fracturing is evident.

9.30 Four-wheel drive to two-wheel drive conversions

9.30.1

A vehicle that has been converted from four-wheel drive to permanent two-wheel drive must meet the requirements specified in 9.30.2 and 9.30.3 if the vehicle:

(a) does not have a selectable four-wheel drive system; and

(b) does not have a solid (live) front axle.

9.30.2

A vehicle specified in 9.30.1 must:

(a) retain and be correctly fitted with any original equipment drive-coupling or constant velocity joint which is relied upon to securely retain a wheel bearing or hub assembly; and

(b) where an original equipment inner constant velocity joint 'cup' remains in place where a half-shaft has been removed, or where a rear driveshaft is removed leaving an exposed tail-shaft spline or yoke, the cup or yoke must be either:

(i) securely attached by a method other than a 'C'-clip to prevent unexpected ejection of the joint, and the resultant escape of any transmission fluid; or

(ii) substituted by a properly machined plug to prevent unexpected ejection of the joint under high load or RPM conditions, and the escape of any transmission fluid.

9.30.2

If a drive-coupling or constant velocity joint is modified (by machining off the CV 'cup') the coupling or joint must retain the unmodified OEM joint main shaft, with the clamping, threaded, splined and stepped sections and locking nut.

9.30.3

A vehicle specified in 9.30.1 must, in addition to the technical requirements specified in 9.30.2:

(a) retain any anti-locking braking system components required by the vehicle's anti-lock braking system to continue to operate correctly; and

(b) when compared to a same make and model unmodified vehicle, exhibit safe handling characteristics during normal road use; and

(c) meet the three-cycle or five-cycle brake performance test requirements of LVV Standard 35-00 (Braking Systems), tested both with and without the anti-lock braking system active, without exhibiting any adverse front-to-rear brake balance characteristics; and

(d) have a warning label supplied by the LVV Certifier attached to the vehicle in a position clearly visible to the driver, that makes a driver aware that the vehicle may handle differently to when it was manufactured in its original four-wheel drive configuration.

9.30.3(c)

In the case of a late-model vehicle fitted with Electronic Brake Distribution (EBD) or other similar system, the ABS must not be deactivated.

Exclusions:

No exclusions apply to this chapter.

Useful information:

Drive-shaft safety-loops

A drive-shaft spins at an extremely high speed, causing a drive-shaft to contain enormous rotational forces.

In the event of a front drive-shaft yoke failure, a flailing drive-shaft can easily penetrate through the vehicle floor injuring vehicle occupants, or impact the road surface below which can cause a loss of directional control or even a roll-over. There have been serious injuries and even fatalities on New Zealand roads over the years, as a result of failed or disengaged drive-shafts.

Drive-shaft safety-loops ensure that in the event of drive-shaft yoke failure, or drive-shaft disengagement (such as through a rear radius rod failure), the massive energy of the disengaged and rotating drive-shaft is contained. For this reason, a drive-shaft safety-loop and its attachment systems must be well-engineered.

All drive-shaft joints, including constant velocity joints, regardless of their construction type, must be treated in the same way as universal joints when determining whether a drive-shaft safety-loop is required to be fitted.

While a carbon-fibre drive-shaft may be much lighter than a traditional steel drive-shaft, it must have a drive-shaft safety-loop as it can still fail. The drive-shaft may contain aluminium or similar materials as part of the composite construction so there is still enough potential for rotational forces to cause major damage, loss of control, or occupant injury.

Solid-mounted engines & gearboxes

There are a few things to remember with solid-mounted engines and gearboxes. Firstly, whilst it's not a safety issue, you'll get a lot more NVH (noise/vibration/harshness) coming through the car with a solid-mounted engine.

Secondly, the most common view on this subject is that if you are solid-mounting the engine at its factory mounting points, the gearbox could be solid-mounted or rubber-mounted. If however you are solid-mounting the engine with a front and mid plate, the gearbox should always be supported by a rubber mount.

Thirdly, opinions differ on this one, but some say that you shouldn't rely on solid mounts where they're only at the front of the engine and rear of the gearbox. In some cases, there won't be enough support at the back of the engine/front of the gearbox. Some experts believe that it's a good insurance policy to use a mid-plate as well in this case.

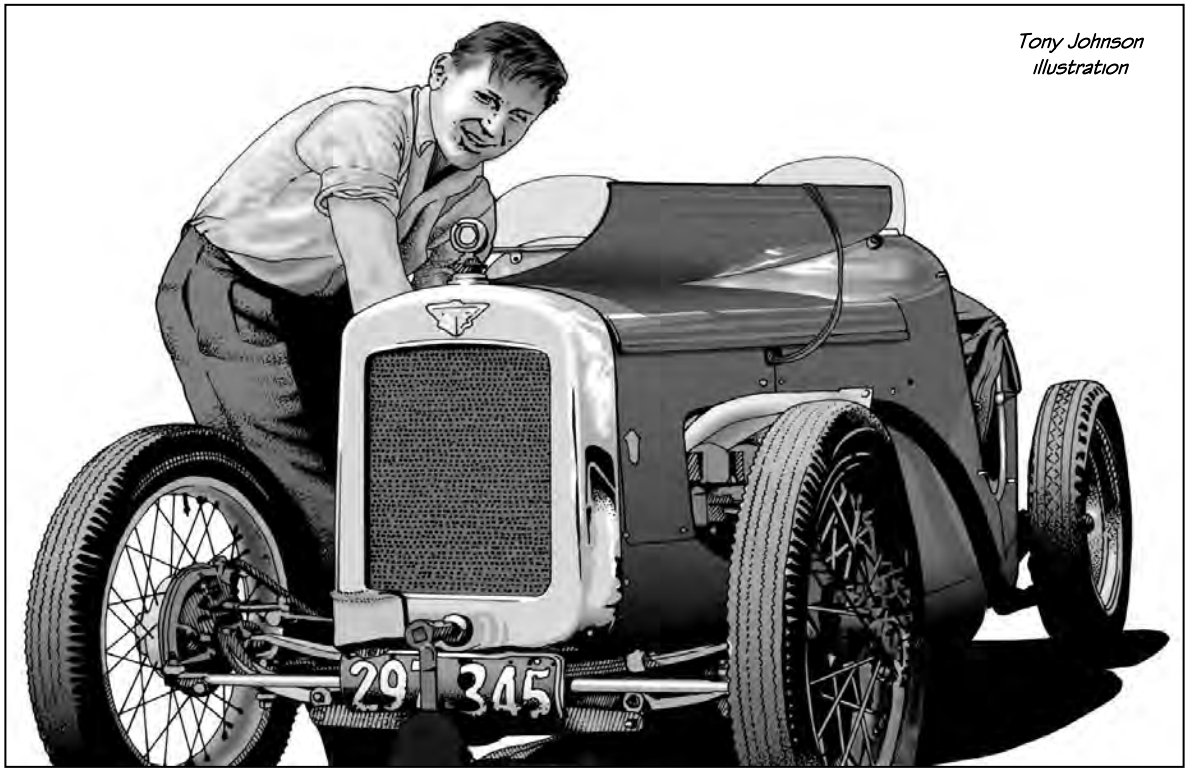
Terms & definitions for Chapter 9 Engine & Drive-train:

Aftermarket	means a component or system made by a manufacturer, other than a high-volume motor vehicle manufacturer, who produces components or systems on a production-run basis for the mass-market.
Alternator	means a device mechanically driven by the engine that provides an electrical supply to maintain the battery's charge.
Automatic transmission	means a type of gearbox, or transmission, that automatically varies the ratios between the input shaft and the output shaft to suit engine speeds automatically, without the driver having to physically select the gears.

Boxed	means to add a capping plate to convert a c-section or channel chassis rail or cross-member to a fully enclosed section like a RHS.
Brinelling	means premature wear of drive-shaft universal bearings due to a lack of rotary movement.
Carbon Fibre Composite	is a strong and light material, usually consisting of a plastic which contains fibres of carbon. A carbon-fibre drive-shaft may also include aluminium in the design.
Capped	means to add a capping plate to convert a c-section or channel-section chassis rail or cross-member to a fully enclosed section like a RHS.
Chassis	means the supporting frame or platform of a motor vehicle to which the major mechanical components and body attach.
Crush-tube	means a section of non-compressible material that is positioned within a cavity, through which a fastener passes, to prevent collapsing of the material surrounding the cavity, and consequential loosening of the fastener.
Cross-member	means a section of material positioned between or connecting the main chassis rails or sections to provide support to the chassis or body, or for the attachment of related components and systems.
Custom	means a service provided, or a component or system manufactured, by an individual person or a company who is not a high-volume motor vehicle manufacturer or aftermarket manufacturer.
Differential	means the mechanical assembly used for transferring the engine and gearbox power output to the driving wheels.
Doubler plate	means a pair of plates that clamp together on either side of a part of a vehicle structure, commonly used as a seat anchorage or a seatbelt anchorage system.
Drive-shaft	means the assembly which transfers the power output from the gearbox to the differential.
Drive-shaft joint	means a device such as a universal joint or a constant-velocity (CV) joint positioned at each end of the drive-shaft, or between multiple drive-shafts, to enable the power transfer to take place from the rigidly-mounted gearbox to the differential operating on an upward and downward plane whilst the suspension operates throughout its range of travel.
Drive-shaft safety-loop	means a safety device designed to contain the drive-shaft in the event of a drive-shaft universal failure, to prevent the drive-shaft from contacting the vehicle floor or the road surface.
Engine hood	means a body panel which is hinged, lift-off, or removeable with hand tools, that gives access to the engine compartment of a vehicle, also known as a bonnet.
Engine mounts	means the devices that fasten the engine onto the chassis or sub-frame section.

Engine plates	means an alternative method of fastening the engine onto the chassis or sub-frame section through the use of a rigid plate system positioned vertically at the front and the rear of an engine, instead of the more common flexible engine mounts.
Fan-belt	means flexible drive-belts, which operate the engine-cooling fan, water, pump, alternator, and other accessory motors from the engine crankshaft pulley.
Gearbox	means the mechanical assembly used to convert engine speed to road speed through the use of a number of different gear ratios.
Gear-shift	means the device by which the different gear ratios in the gearbox are selected.
Gearbox tunnel	means the floor of a motor vehicle surrounding the area where the gearbox is positioned.
Locked differential	means a differential that drives both left and right-side axles simultaneously without the usual mechanical slippage designed into production motor vehicles to provide safe and comfortable cornering.
Longitudinal	means in the fore-aft direction, running on or parallel to the centre-line of the vehicle.
LVV Certifier	means a person appointed by the New Zealand Transport Agency to inspect and approve modified and scratch-built vehicles, under the Low Volume Vehicle Code.
Monocoque	means a type of vehicle construction that incorporates the vehicle body and chassis frame in one unit, as opposed to having a separate and removable chassis.
mm	is an abbreviation for millimetres.
Nitrous oxide	means a liquid chemical composition of one part of nitrogen and two parts of oxygen, which when introduced with the fuel mixture entering an internal combustion engine, converts to a gas and may increase the oxygen content in the combustion chamber producing a momentary increase in power output.
Nyloc	means a type of vibration-proof locking nut that incorporates a nylon section, which enables the nut to lock itself against the corresponding bolt.
OE	is an abbreviation for original equipment.
Original equipment	means components that were part of a mass-produced vehicle's equipment at the time of its manufacture.
RHS	is an abbreviation for rectangular hollow section, which is a configuration of steel section commonly used in the manufacture of chassis and other motor vehicle component fabrication.
Spool	means a device which when fitted, has the effect of a locked differential.
Square mm	means an area measured by multiplying the height by the width. For example, a rectangle 80 mm high and 50 mm wide has an area of 4000 square mm.

RPM	is an abbreviation for revolutions per minute, a measurement of engine speed.
Sub-frame	means a structural part of a unit-construction vehicle to which the major mechanical components attach.
Supercharged	means a mechanical device driven by the crankshaft pulley of an engine which forces an air/fuel mixture into the engine to provide increased levels of power output.
Torque	means rotating effort produced by applying a force to a lever arm about a pivot.
Unitary construction	means a type of vehicle construction that incorporates the vehicle body and chassis frame in one unit, as opposed to having a separate and removable chassis.



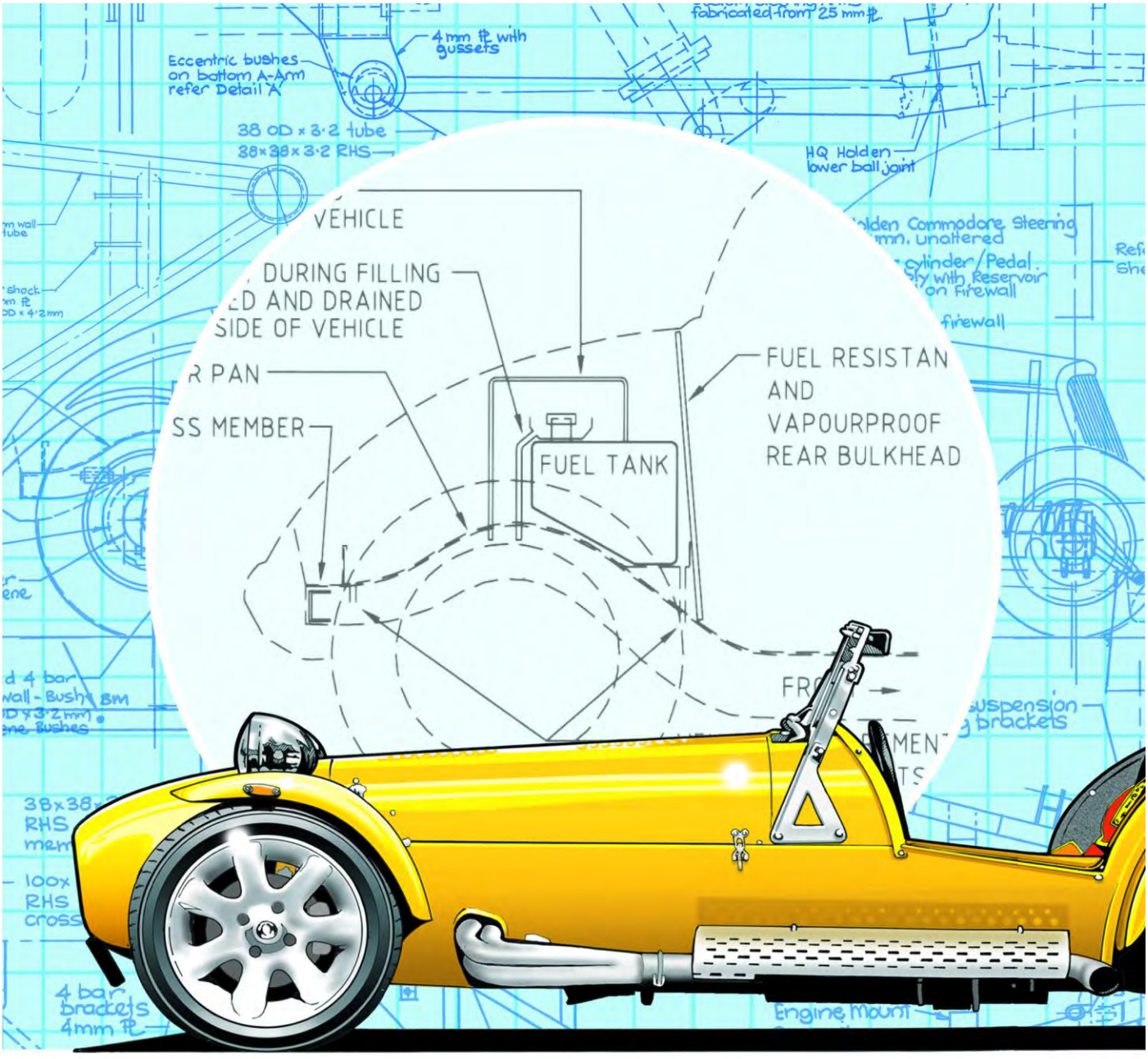
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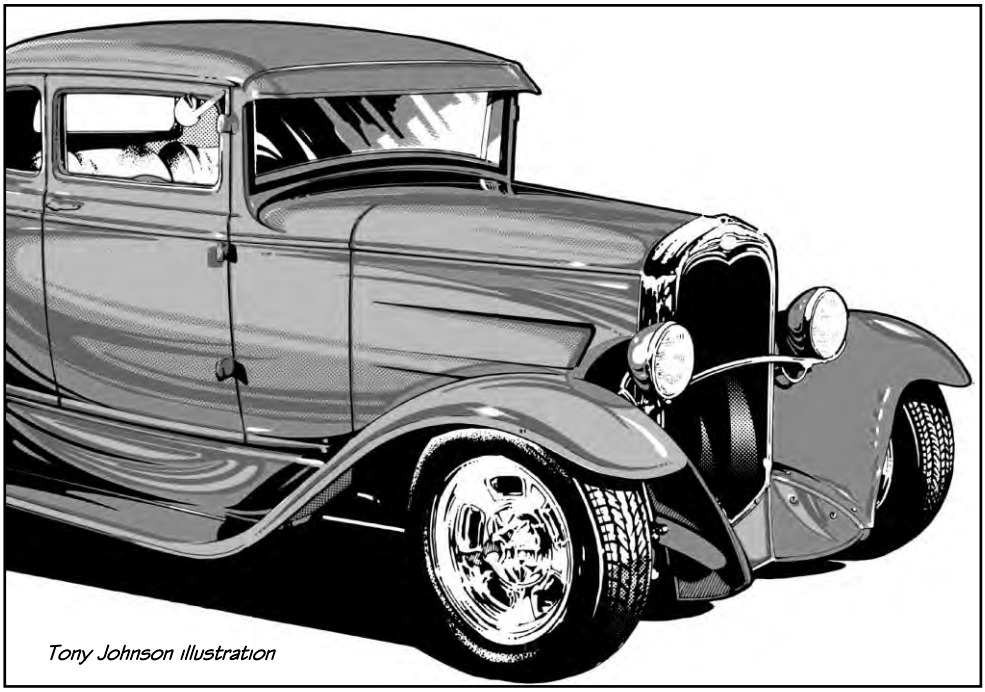
Chapter 10
Fuel Systems

2nd Amendment | Effective from 1 July 2021



Low Volume Vehicle Technical Association (inc)

Chapter 10
Fuel Systems



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On (date):.....by, on behalf of:	
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The information in this NZ Car Construction Manual Chapter has stemmed from work undertaken by LVVTA founding member organisations that commenced prior to 1990 and has been progressively developed as an integral part of New Zealand Government safety rules and regulations by agreement and in consultation with the New Zealand Transport Agency.

As a result, the considerable experience in applied safety engineering built up by LVVTA and the specialist automotive groups over the past several decades can be of benefit to members of the New Zealand public who also wish to build or modify light motor vehicles.

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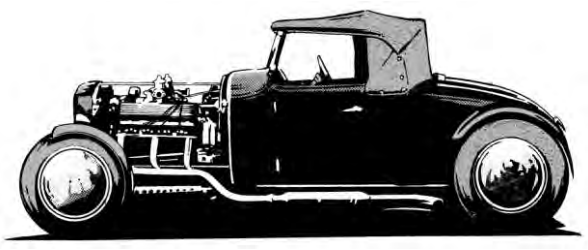
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- Authorship & artwork: Tony Johnson
- Technical content: New Zealand Hot Rod Association (inc), LVVTA Technical Staff, LVVTA Technical Advisory Committee

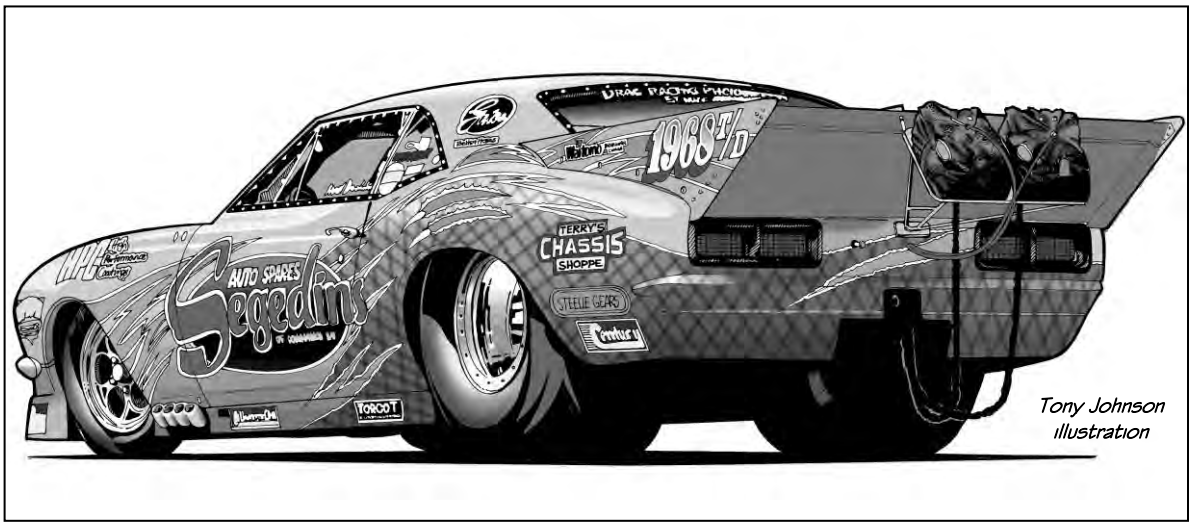
Type Key: (For full details of Text Key, refer to Chapter 2 – About this Manual)

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Normal type in shaded box:	Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates.
Script type:	Helpful hints, tips, explanations, clarifications, and interpretations.
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Tony Johnson illustration

CHAPTER 10: FUEL SYSTEMS

Introduction:

The purpose of this Chapter is to specify sound design principles relating to fuel systems, to ensure that all new or modified fuel systems in low volume vehicles are as safe as practicable.

A vehicle's fuel system is important in terms of safety, performance, and reliability. A good fuel system in a low volume vehicle is dependent on the correct selection or construction of the tank, tank location within and attachment to the vehicle, correct venting, spillage and leakage dispersal, and care, even on the little things like fuel hoses and fittings.

Note that where a production vehicle is fitted with its original fuel tank or other fuel system components in their original locations, the requirements in this chapter do not apply. Note also that this chapter does not apply to components associated with compressible fuel types such as CNG, LPG, or hydrogen, all of which require a separate alternative fuels certification.

General safety requirements:

10.0 Requirements applicable to all vehicles

10.0.1

A low volume vehicle must:

(a) be designed and constructed using materials and components that are fit for their purpose; and

(b) be safe to be operated on the road.

10.0.1

This is from 2.3 of Part 2 of the LVV Code, which makes it clear that, regardless of what technical requirements are or are not in place, every vehicle certified to the LVV Code must be fit for its purpose, and must be safe.

10.0.2

Fuel tanks, fuel lines and associated components in a motor vehicle must be:

(a) securely mounted; and

(b) made of suitable materials; and

(c) in good condition; and

(d) free from significant leaks; and

(e) positioned so that the risk of mechanical damage or heat gain is minimised.

Fuel tank requirements:

10.1 Surge tanks

10.1.1

A surge-tank fitted to a low volume vehicle must, with the exception of 10.2.6, meet all of the same technical requirements that are specified in this Chapter for fuel tanks.

10.2 Fuel tank construction

10.2.1

A custom or aftermarket fuel tank may be fitted to a low volume vehicle as an alternative to a fuel tank from a mass-produced vehicle, provided that the tank is constructed from fuel-resistant and corrosion-resistant materials, with a minimum thickness of:

(a) in the case of aluminium, 1.6 mm (16-gauge); or

(b) in the case of stainless steel, 1.0 mm (20-gauge); or

(c) in the case of 'electro-galv' mild steel, 1.2 mm (18-gauge).

Where a low volume vehicle built or modified before 1992 has a fuel tank that does not comply with 10.2.1, the tank may be retained provided that in the opinion of the Low Volume Vehicle Certifier the tank has demonstrated through the test of time that it is still in good condition and is fit for its purpose.

10.2.2

The sections of a custom or aftermarket fuel tank fitted to a low volume vehicle made from materials specified in 10.2.1 must be either gas or electric-welded.

10.2.3

A custom or aftermarket fuel tank fitted to a low volume vehicle that is constructed from materials specified in 10.2.1 may be modified, provided that the strength of the tank is not reduced.

10.0.2

These are the applicable general safety requirements from the Land Transport Rule 32017 Vehicle Equipment 2004, which are required as part of this Chapter, and reproduced here in the interest of convenience.

10.0.2(d)

An LVV Certifier is likely to treat any fuel leak as 'significant'.

10.1.1

Refer to the Useful Information section at the back of this chapter for more details about fuel-injection 'surge-tanks'.

10.2.1

A permanently corrosion-protected material is regarded as being corrosion-resistant.

If steel is used, it should be specifically 'electro-galv' steel, such as the 'zintec' brand.

If using 'electro-galv', the tank should be sealed internally with a proper fuel tank sealant after welding to prevent corrosion of weld joints.

10.2.2

Soldering must not be used for joining fuel tank sections, or attaching mounting points, but may be used for the attachment of fuel tank fittings.

10.2.4

A fuel tank that is constructed from a material which is not listed in 10.2.1 may be fitted to a low volume vehicle, provided that the tank is either:

(a) sourced from a high-volume production vehicle; or

(b) manufactured by a recognised manufacturer of motor sport, automotive, or marine fuel tanks or fuel cells; or

(c) manufactured by someone other than that specified in 10.2.4(a) or (b), but is individually approved in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc).

10.2.5

A fuel tank fitted to a low volume vehicle, that is constructed from a material which is not listed in 10.2.1, must not be modified in any way by any person or company other than a person or company specified in 10.2.4(c).

10.2.5

Plastic tanks in particular should never be modified or repaired due to the types of materials used in the construction of these tanks.

10.2.6

A custom or aftermarket fuel tank fitted to a low volume vehicle must incorporate some form of baffling to minimise fuel surge within the tank during cornering, braking, and acceleration.

10.2.6

Baffling can include a fuel-resistant foam appropriate for the type of fuel used.

10.2.7

A fuel tank fitted to a low volume vehicle must not have any fuel lines positioned on the underside of the fuel tank unless they are suitably protected from road debris and jacking.

10.3 Fuel tank location & protection

10.3.1

A fuel tank and its related fuel system components may be located within the boot or passenger compartment of a low volume vehicle, provided that the requirements specified in 10.6 and 10.7 are met.

10.3.2

A fuel tank fitted to a low volume vehicle that is constructed from a material which is not listed in 10.2.1, must, other than for an L-class vehicle, be protected by a structural cross-member, chassis or sub-frame section, or rigid body section, between the tank and any outer extremity of the vehicle. (see Diagrams 10.1 & 10.2)

10.3.2

An 'L-class' vehicle is a motorcycle or trike.

Fuel tanks should be positioned so that they are protected during an impact.

Where a low volume vehicle built or modified before 1992 has a fuel tank that is not protected as required by 10.2.2, the tank may be retained in its location provided that in the opinion of the Low Volume Vehicle Certifier the tank positioning is not unsafe.

10.3.3

A fuel tank fitted to a low volume vehicle must be protected from any exhaust heat by either:

(a) the inter-positioning of a suitably fabricated and mounted heat-shield between the fuel tank and the exhaust system; or

(b) either:

(i) in the case of a fuel tank which is specified in 10.2.1, be positioned so that there is a minimum clearance between the fuel tank and the exhaust system of 25 mm; or

(ii) in the case of a fuel tank that is constructed from a material which is not listed in 10.2.1, be positioned so that there is a minimum clearance between the fuel tank and the exhaust system of 50 mm.

10.3.4

No part of a fuel tank fitted to a low volume vehicle may be located forward of the vehicle's front axle centre-line.

10.3.4

Traditional hot rod 'Moon' style tanks may be fitted to the front of a hot rod, provided they are not functional.

10.3.5

A fuel tank and its related fuel system components must be located within a low volume vehicle so that: (see Diagrams 10.1 & 10.2)

(a) the fuel tank and systems remain within the scrub-line of the vehicle, so that in the event of a tyre deflation, the fuel tank will not come into contact with the road surface; and

(b) no part of the fuel tank or fuel system is positioned at a point where damage could be caused by a curb, judder bar, or other road irregularities; and

(c) where there is less than 200 mm (8") clearance between the lowest part of the tank and the ground, the tank is protected by either:

(i) an adjacent part of the vehicle structure; or

(ii) a suitable shield or other vehicle component capable of protecting the tank.

10.3.5

This is aimed at preventing fuel tanks being damaged or ruptured through being positioned too low, particularly when crossing curbs.

10.3.5(a)

'Scrub-line' is the line drawn across the vehicle's width from the bottom of one wheel-rim to the contact patch of the opposite side tyre, and vice-versa.

10.4 Fuel tank attachment

10.4.1

A fuel tank must be attached to a low volume vehicle using:

(a) an attachment method that:

(i) is suitable for the type and size of the tank; and

(ii) uses components and materials that are equivalent to or greater than that used by a production vehicle using a similar tank location and capacity;

and

(b) fasteners that meet the general fastener requirements and 'locking device requirements' specified in 'Chapter 18 - Attachment Systems'.

10.4.2

A replacement fuel tank that is of a substantially greater capacity than that originally fitted to a modified production low volume vehicle must either:

(a) have an attachment system that has a greater load-carrying ability than that provided by the original vehicle manufacturer; or

(b) incorporate additional support to supplement the attachment system provided by the original vehicle manufacturer.

10.4.2

If a much larger than standard fuel tank has been fitted to a production vehicle, additional supports or mounts may be required.

10.5.2

See Diagrams 10.1 & 10.2 for the positioning of an isolation panel.

10.5.2 means, in effect, that because of the practical difficulties associated with providing an isolation panel in a hatch-back type vehicle (where the boot area is part of the passenger compartment), a hatch-back type vehicle cannot be filled from inside the vehicle.

Refer to the Useful Information section at the back of this chapter for more details about 'sealing the boot area from the passenger compartment'.

10.5 Fuel tank filling

10.5.1

A fuel tank fitted to a low volume vehicle must incorporate a correctly-fitting filler cap which: (see Diagrams 10.1 & 10.2)

(a) prevents fuel from leaking out of the fuel tank as a result of fuel surge during cornering, braking, and acceleration; and

(b) either:

(i) is a sealed or vented filler cap in the case of a fuel tank that is filled from outside the vehicle; or

(ii) is a sealed filler cap in the case of a fuel tank that is located and filled from inside the vehicle.

10.5.2

A fuel tank fitted to a low volume vehicle may be filled either:

(a) from outside of the vehicle; or

(b) from inside the vehicle, only if an impervious and fully-sealed isolation panel made from a fuel-resistant material is fitted to prevent fuel during a filling spillage, or fuel vapour, from entering the passenger compartment (see Diagrams 10.1).

10.5.3

A fuel tank fitted to a low volume vehicle, which is filled from inside the vehicle, must incorporate a means of catching any fuel during a refilling over-flow or spill, and dispersing it to the outside of the vehicle without spilling onto either: (see Diagrams 10.1 & 10.2)

(a) any part of the vehicle's exhaust system; or

(b) any part of the vehicle's electrical system.

10.6 Fuel tank leakage & rupture dispersal

10.6.1

A low volume vehicle that has a fuel tank located inside the trunk or passenger compartment must have the floor and surrounding area in which the fuel tank is located designed in such a way that any fuel, in the event of a fuel tank leak or rupture: (see Diagrams 10.1 & 10.2)

(a) cannot come into contact with the vehicle's battery or battery leads; and

(b) will escape to the outside of the vehicle, without draining onto either:

(i) any part of the vehicle's exhaust system; or

(ii) any part of the vehicle's electrical system.

10.6.2

A scratch-built low volume vehicle completed after 1 January 2008 must incorporate a means of preventing fuel leakage from the tank if the vehicle is upside down.

10.7 Fuel tank safety venting

10.7.1

A fuel tank fitted to a low volume vehicle that incorporates a safety venting system, must either:

(a) discharge vapour to the outside of the vehicle, away from: (see Diagrams 10.1 & 10.2)

(i) any part of the vehicle's exhaust system; or

10.5.3

This can be achieved by incorporating a simple spill-ring around the filler neck that collects and drains any excess fuel to the outside of the vehicle.

10.6.1

The intent of this clause is to prevent fuel from a fuel tank rupture, from gathering within the trunk area or passenger compartment. A simple drainage system can be incorporated into the floor where the tank is mounted, to prevent spilt fuel from collecting and remaining in the boot or entering the passenger compartment. 'Inside the vehicle' includes on top of the deck or tray of a utility.

10.6.2

In the case of an internally-mounted, externally-vented tank, this can be achieved by incorporating a one-way check-valve within the external vent system.

10.7.1

Older tanks use a vent or breather pipe to equalise air pressure within the tank, while modern tanks working with fuel-injected engines operate under a mild vacuum. Fuel tanks fitted to these vehicles must, therefore, be substantial enough to resist the deformation that can be caused through the constant residual vacuum designed into such systems.

(ii) any part of the vehicle's electrical system;

or

(b) in vehicles with carbon-vent canisters fitted, purge to the engine intake system in the same way as they are originally designed to do.

10.7.1

Builders need to be aware of the type of systems being used, especially with modern fuel-injected engines.

Where possible, the vent line should run to below the lowest point of the fuel tank. If this is impractical, a proprietary roll-over one-way check-valve can be incorporated.

All fuel systems must incorporate both entry and exit venting. This can be as simple as the fuel tank vent (or breather) shown in the diagrams.

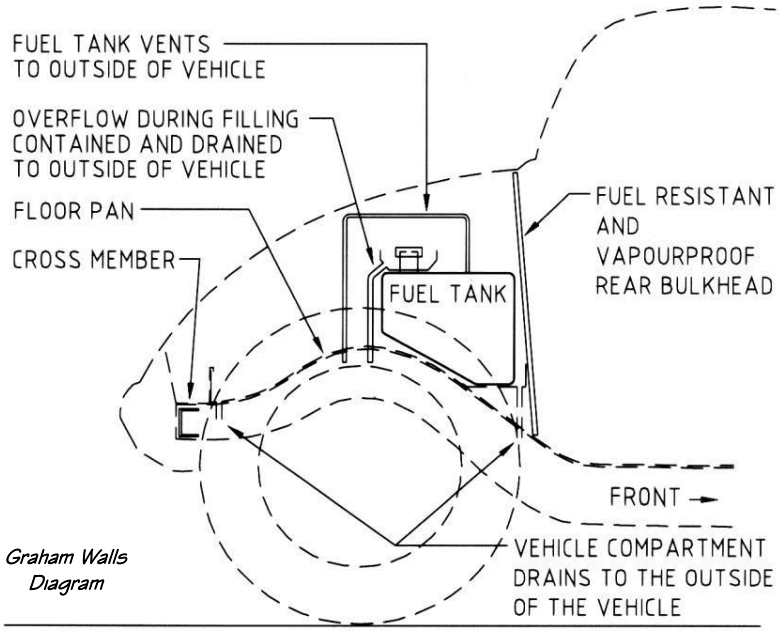


Diagram 10.1 Fuel tank with fill point located internally

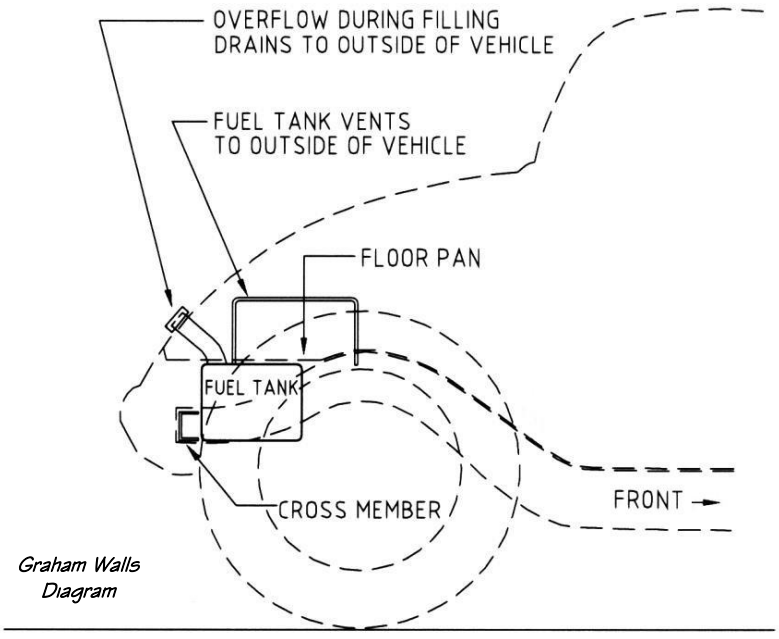


Diagram 10.2 Fuel tank with fill point located externally

10.7.1

In a configuration such as that shown in Diagram 10.2 where the fuel tank is mounted under the floor and filled externally, a fuel-resistant and vapour-proof bulkhead (as shown in Diagram 10.1) is not required.

Whenever a pressurised fuel feed line is in the boot, a bulkhead will need to be present, even for an under-floor and externally-filled system.

10.7.2

A fuel tank safety-vent system fitted to a low volume vehicle must prevent any fuel from being able to be discharged through the vent (see Diagrams 10.1 & 10.2).

10.7.2

The vent outlet should ideally discharge on the side of the tank that is opposite to where the vent pipe exits from the tank, and terminate below the lowest part of the tank, in order to protect against fuel spill during high G-forces.

Fuel pipe and hose requirements:

10.8 Fuel pipes and hoses

10.8.1

A low volume vehicle must incorporate a flexible fuel connection between the engine and the chassis, sub-frame, or body structure of the vehicle.

10.8.1

While coiled solid fuel pipe can meet this requirement, flexible fuel hose is preferred.

10.8.2

Flexible fuel hoses used within a fuel system in a low volume vehicle must be manufactured from a reinforced synthetic fuel-resistant rubber, or other fuel-resistant non-hardening flexible material, designed for automotive fuel-carrying applications.

10.8.3

Fuel pipes and hoses, and their fittings, fitted to a low volume vehicle, must be suitably matched to the operating pressure of the fuel system being used.

10.8.3

Modern fuel-injected engines run at very high pressures, and special care must be taken to ensure that the best quality hoses and fittings are used.

10.8.4

A push-on join between a flexible fuel hose and a rigid fuel pipe or fitting on a low volume vehicle must be secured with a suitable hose-clamp or clip to prevent unintended disconnection due to fuel delivery pressure or vehicle vibration.

10.8.4

'Swaged' pipe ends are highly recommended in all pipe to hose connections.

Push-lock fittings with multiple barbs are designed to grip the hose sufficiently as to not need a clamp. The hose can be damaged if a clamp is used with a push-lock fitting.

10.9 Fuel pipe and hose location & attachment

10.9.1

Rigid fuel pipes and flexible fuel hoses fitted to the underside of a low volume vehicle may only be:

(a) tubular steel, aluminium, copper, or stainless-steel rigid fuel pipe; or

(b) premium quality stainless-steel braided fuel hose; or

(c) suitably reinforced high-pressure fuel hose.

10.9.1

See side-bar text for 10.9.1 on the next page.

10.9.2

Rigid fuel pipes and flexible fuel hoses fitted to a low volume vehicle must not be positioned:

(a) on the underside of chassis or sub-frame rails or cross-members unless suitably protected from road debris or jacking damage; or

(b) adjacent to exposed electrical connections, fittings, or wires, unless suitably protected from potential fuel leakages; or

(c) adjacent to any moving mechanical components including drive-shafts, pulleys, fans, or supercharger drive systems, unless suitably protected; or

(d) within the maximum possible travel of a failed drive-shaft rotating inside the circumference of the drive-shaft safety-loop.

10.9.3

Rigid fuel pipes and flexible fuel hoses fitted to a low volume vehicle must either:

(a) be protected from any exhaust heat by the inter-positioning of a suitably fabricated and mounted heat-shield; or

(b) be provided with no less clearance from the exhaust system than that designed by the vehicle manufacturer; or

(c) be positioned so that there is a minimum clearance between the component and the exhaust system of:

(i) in the case of any part of the exhaust system other than a catalytic converter, 50 mm; or

(ii) in the case of a catalytic converter, 100 mm.

10.9.4

Rigid fuel pipes and flexible fuel hoses fitted to the underside of a low volume vehicle must be secured firmly against the chassis, sub-frame, or body structure, at intervals of no more than:

(a) in the case of a modified production vehicle with standard pipes and hoses, as the original manufacturer provided; or

(b) in the case of a scratch-built vehicle or a non-original fuel system on a modified production vehicle, 300 mm (12").

10.9.5

Rigid fuel pipe or flexible purpose-designed automotive braided stainless-steel covered fuel hose may be located within the passenger compartment of a low volume vehicle, provided that:

(a) the hose cannot come in contact with either the driver or other vehicle occupants during normal vehicle operation; and

10.9.1

Flexible fuel hoses should ideally be kept to a minimum because they are more susceptible to damage and wear than rigid fuel pipe, and they should also be in a visible location for easy inspection for wear and damage.

10.9.1(a)

Fuel pipe can be made from seamed or seamless material.

10.9.1(c)

'Push-lock' hose is a common type of hose that is suitable for fuel hose.

10.9.4

Fuel pipes and hoses can be run inside chassis rails, but if so, must still be secured, as pipes and hoses can rub and chafe if left loose.

An approved alternative is for fuel pipes and hoses to pass through a well-secured tubular section, known as a 'service tube', provided that the fuel pipes and hoses are suitably supported, and cannot whip or flex.

10.9.5

Note that some motor-sport safety regulations, (for example NZ Drag Racing Association), do not allow fuel hoses inside passenger compartments.

(b) the pipe or hose is secured firmly against the floor at intervals of no more than 300 mm (12”); and

(c) the hose can be readily inspected for wear or damage; and

(d) there are no pipe or hose joins or connections inside the passenger compartment, other than:

(i) where the pipe or hose transfers fuel through an aperture in a front or rear firewall, using purpose-designed bulkhead fittings; or

(ii) in the case of a fuel tank located inside the passenger compartment, the connection to the fuel tank; or

10.9.5(d)

This doesn't apply to fuel lines which are subject to vacuum (rather than pressure), and where the fuel lines which are positioned inside the passenger compartment remain above the fuel tank level to avoid syphoning.

10.9.6

A flexible fuel hose must, where passing through an opening in a panel or chassis or sub-frame section in a low volume vehicle, be secured or protected to prevent chafing or rubbing against any hard or sharp edges.

Other requirements:

10.10 Fuel pumps

10.10.1

Dry electric fuel pumps are a major ignition source.

10.10.1

A mechanical or electrical fuel pump fitted to a low volume vehicle must be protected from exhaust heat by either:

(a) being positioned at a safe distance away from the exhaust system; or

(b) being protected by the inter-positioning of a suitably fabricated and mounted heat-shield.

10.10.2

Wiring of internally mounted fuel pumps, auxiliary fuel pumps, or transfer pumps, is a specialised field and should be left to auto-electrical experts.

10.10.2

A fuel pump that supplies a fuel injection system in a low volume vehicle, must be prevented from being able to be operated when:

(a) there is no fuel in the fuel tank; or

(b) the engine is not running.

10.10.2(b)

'Running' means running continuously - operation of the fuel pump prior to normal engine start-up is acceptable.

10.10.3

Where a battery, and fuel system components, such as a fuel tank or fuel pump, are located within the same compartment in a low volume vehicle, the battery and the fuel system components must be separated from each other by the enclosure of one or both within a secured fuel-resistant non-conductive container.

10.10.3

A marine or motor-sport 'battery box' is ideal in this situation.

References to a 'compartment' do not include an engine bay.

10.11 Alternative fuels

10.11.1

An alternative fuel system, including CNG and LPG, must be located and attached in accordance with the requirements specified for alternative fuels within Land Transport Rule 32017 Vehicle Equipment 2004.

10.11.1

The presence of a valid alternative fuel certificate meets this requirement.

10.11.2

A nitrous oxide system must meet the requirements specified for nitrous oxide systems in 'Chapter 9 - Engine & Drive-train'.

Exclusions:

No exclusions apply to this chapter.

Useful Information:

Surge tanks

A 'surge tank' is used to make sure that the fuel pump inlet doesn't become starved for fuel, particularly during sustained acceleration. A surge tank is most often used in conjunction with electronic fuel injection systems.

Sealing the boot area from the passenger compartment

It's important to understand that the area in which a fuel tank, surge tank, fuel pump, or any other fuel system component (except for a fuel pipe or fuel hose) is housed, cannot be the same area as the area in which the vehicle occupants sit. When a fuel tank, surge tank, or fuel pump is positioned in the boot, and there is not a fully-sealed and impervious isolating panel separating the two areas, then this basic rule is broken, because a normal factory-installed perforated rear seatback support panel and rear seat does not properly isolate occupants from fuel or fuel vapour.

Similarly, if a leak or rupture occurs, or fuel is spilled during the filling process, the resulting fuel must be prevented from collecting and remaining in the boot area of the vehicle, or from entering the passenger compartment. The fuel system also has to be designed to prevent a leak draining onto either the exhaust or any part of the electrical system, including the battery or battery leads.

These principles also cover the situation of a pressurised fuel leak from a surge tank.

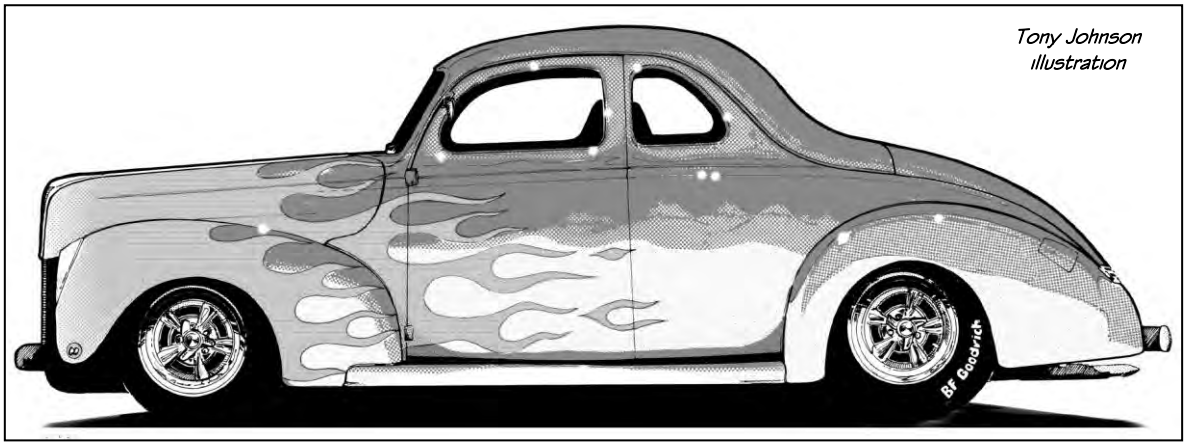
These vapour, rupture, leakage, and spillage situations need to be considered very carefully in the situation where an aftermarket fuel tank is mounted inside the vehicle, and even more-so when the fuel tank requires filling from inside the vehicle.

While it's practical to fit such a fully sealed and impervious isolation panel into the back of a regular sedan-type vehicle, it would be almost impossible in the case of a hatch-back where the boot space and the passenger compartment are effectively one and the same. In this case, the fuel system components must be fully sealed, or mounted outside the passenger compartment.

Terms & definitions for Chapter 10 Fuel Systems

Aftermarket	means a component or system made by a manufacturer, other than a high-volume motor vehicle manufacturer, who produces components or systems on a production-run basis for the mass-market.
Baffling	means, in the context of this manual, a barrier to prevent splashing and surging of fuel in a fuel tank, during braking, accelerating, and cornering.
Carbon-vent canister	means an activated carbon canister which is used to capture hydrocarbon vapor emissions from a fuel tank as part of an evaporative emission control system.
Check-valve	means a one-way safety-valve which closes in order to prevent backward flow of fuel, and in relation to a fuel system it refers to a safety-valve installed in the fuel tank breather line which operates in only one direction, which prevents fuel from coming out of the breather line in the event of a roll-over.
Custom	means a service provided, or a component or system manufactured, by an individual or a company who is not a high-volume motor vehicle manufacturer or an aftermarket manufacturer.
Electro-galv	is an abbreviation for electrogalvanizing.
Electrogalvanizing	is a process in which a layer of zinc is bonded to steel in order to protect against corrosion. The process involves running a current of electricity through a saline/zinc solution with a zinc anode and steel conductor.
Fuel surge	is the effect of fuel being pushed away from the pick-up point of a fuel system, usually during hard cornering or acceleration, resulting in air pockets in the fuel lines.
L-class	is a New Zealand Transport Agency classification, which means, in very simple terms, a two-wheeled motorcycle or three-wheeled motor vehicle with a GVM of under 1000 kg.
Low volume vehicle	means, in simplest terms, a vehicle that is built or modified in small numbers, and includes individual home-built or modified vehicles. See the full low volume vehicle definition contained in the Low Volume Vehicle Code.
mm	is an abbreviation for the metric measurement of millimetres.
Modified production (low volume vehicle)	means, in simplest terms, a vehicle which, while modified, maintains a sufficient percentage of body or chassis from one primary mass-produced vehicle, that it can still be considered to be that vehicle. See the full modified production (low volume vehicle) definition contained in the Low Volume Vehicle Code.
Moon-style tank	means a fuel tank manufactured by the Moon Equipment company of Southern California, which in the context of this manual, is of a style that is traditionally used in hot rods, mounted ahead of the vehicle's grille and above the front axle.

Nitrous oxide	is a liquid chemical composition of one part of nitrogen and two parts of oxygen, which when introduced with the fuel mixture entering an internal combustion engine, converts to a gas and may increase the oxygen content in the combustion chamber producing a momentary increase in power output.
Passenger compartment	means the part of a motor vehicle body that houses the passengers and driver.
Pressurised system	means a fuel system which operates under a constantly-metered pressure, to reduce the risk of interruption of fuel flow to an engine.
Push-lock	means a type of hose and fitting system that enables the hose to be easily pushed on, however because of the design of the male fitting, the hose grips against the male fitting such that its removal is very difficult.
Scratch-built	is as defined in the Low Volume Vehicle Code.
Scrub-line	means the line drawn across a vehicle's width from the bottom of one wheel to the contact patch of the opposite side tyre, and vice-versa.
Suction-only system	means a fuel system which delivers fuel to an engine by suction, usually through an electrically or mechanically-operated fuel pump.
Surge-tank	means a small tank used to hold the fuel to prevent fuel from moving away from the fuel pump pickup during cornering, acceleration, and braking.
Swaged	means a pressing formed at the end of a section of fuel pipe (instead of, or in addition to, using a hose clip).
Zintec	is the trade name given to cold-rolled and coiled mild steel sheet that has been electrolytically coated with a thin layer of zinc as part of the manufacturing process.



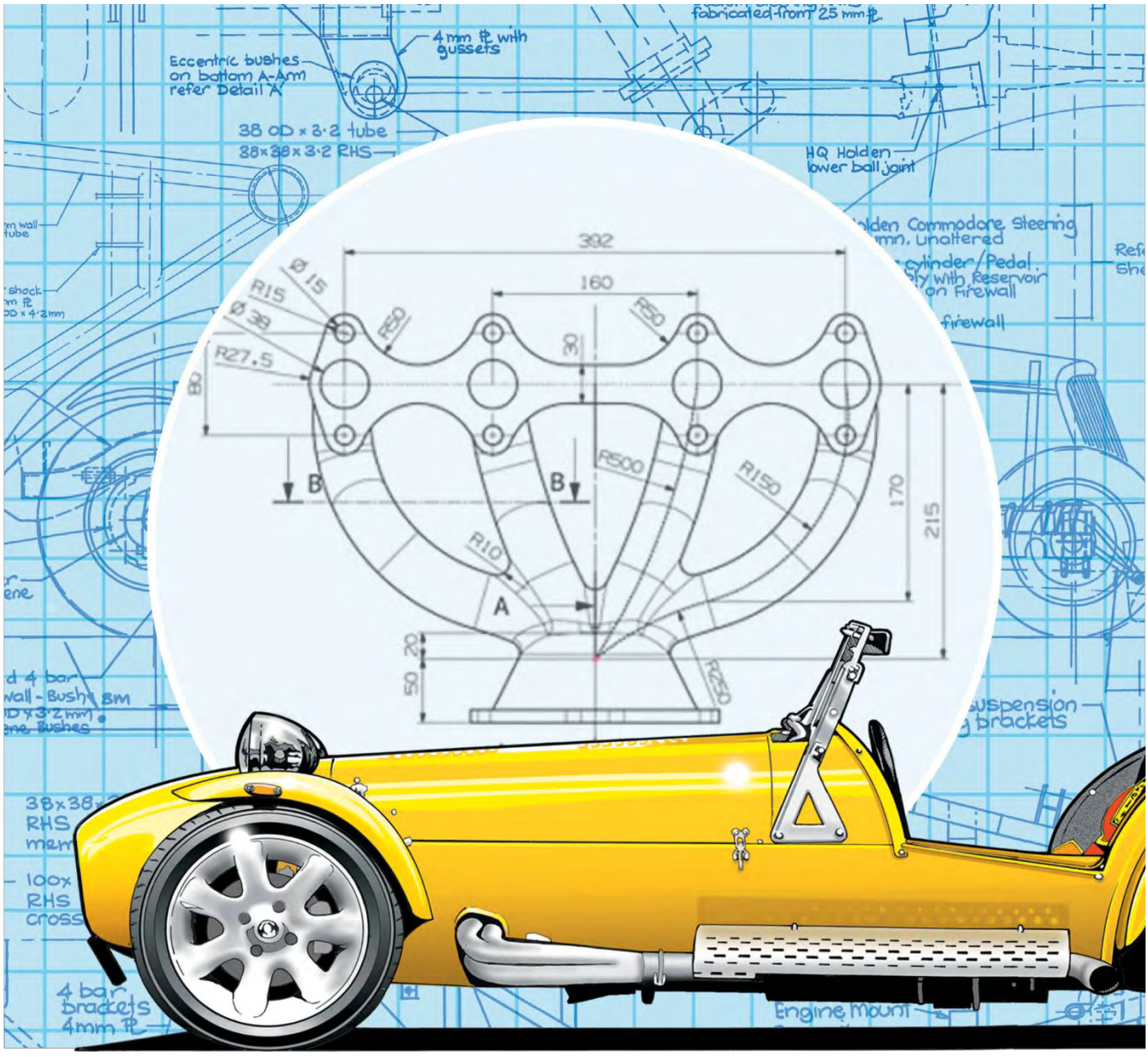
Low Volume Vehicle Technical Association (inc)

Helping New Zealanders Build & Modify Safe Vehicles

New Zealand Car Construction Manual

Chapter 11 (Part 1)
Exhaust Noise & Gas Emissions

Version 1 | Effective from 1 October 2025



Low Volume Vehicle Technical Association (inc)

Chapter 11 (Part 1)
Exhaust Noise & Gas Emissions



Tony Johnson Illustration

Approval Record

Signed in accordance with clause 1.3(5) of the *Low Volume Vehicle Code* of the LVVTA	
On (date)..... on behalf of	
New Zealand Transport Agency	Low Volume Vehicle Technical Association .....

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About Car Construction Manual Chapters

NZ Car Construction Manual Chapters (the chapters) provide the necessary detailed technical requirements, and helpful information, to enable a low volume vehicle to comply with the corresponding low volume vehicle standards (LVV standards). The chapters provide modifiers and constructors with the same information that an LVV Certifier will use when inspecting and LVV certifying a modified or scratch-built vehicle.

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The information in this chapter has stemmed from work undertaken by LVVTA founding member organisations that commenced in 1989 and has been progressively developed as an integral part of the New Zealand Government's land transport regulatory system, by agreement and in consultation with the New Zealand Transport Agency (NZTA).

As a result, the considerable experience in applied safety engineering built up by LVVTA and its specialist automotive member groups over the past several decades can be of benefit to members of the New Zealand public who also wish to build or modify motor vehicles.

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This chapter is constantly undergoing an evolutionary development process in order to keep pace with changing trends and technology. To assist in this, LVVTA invites users of this chapter to engage in an ongoing consultation process with us by making submissions for any changes, additions, or clarifications which might improve the chapter, at any time.

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This chapter supports *LVV Standard 90-20 – Exhaust Noise Emissions*, which is incorporated within the *Low* Volume *Vehicle Code* (*LVV Code*). The *LVV Code* is, in turn, incorporated by reference within *Land Transport Rule: Vehicle Standards Compliance 2002*.

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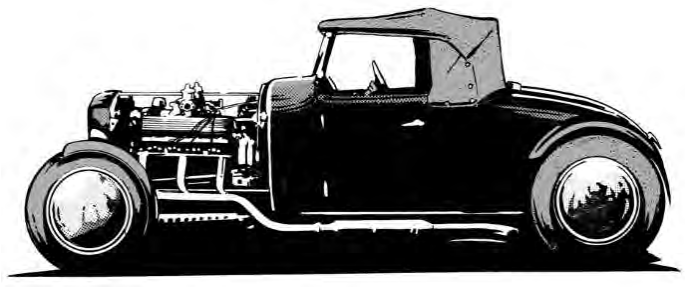
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- All car illustrations: Tony Johnson

Type Key (For full details of Type Key, refer to Chapter 2 – About this Manual)

Normal type	Provisions of the NZ Car Construction Manual for all vehicles.
Normal type in shaded box:	Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates.
Script type:	Helpful hints, tips, explanations, clarifications, and interpretations.
Grey shaded text & grey vertical stroke in margin:	Latest amendments since previous version. Note that text which is high-lit in grey shows amendments that have been made since the document's previous version, and a grey vertical stroke to the left of the text denotes new or changed information which is important (rather than just a grammatical, formatting, or numbering change).



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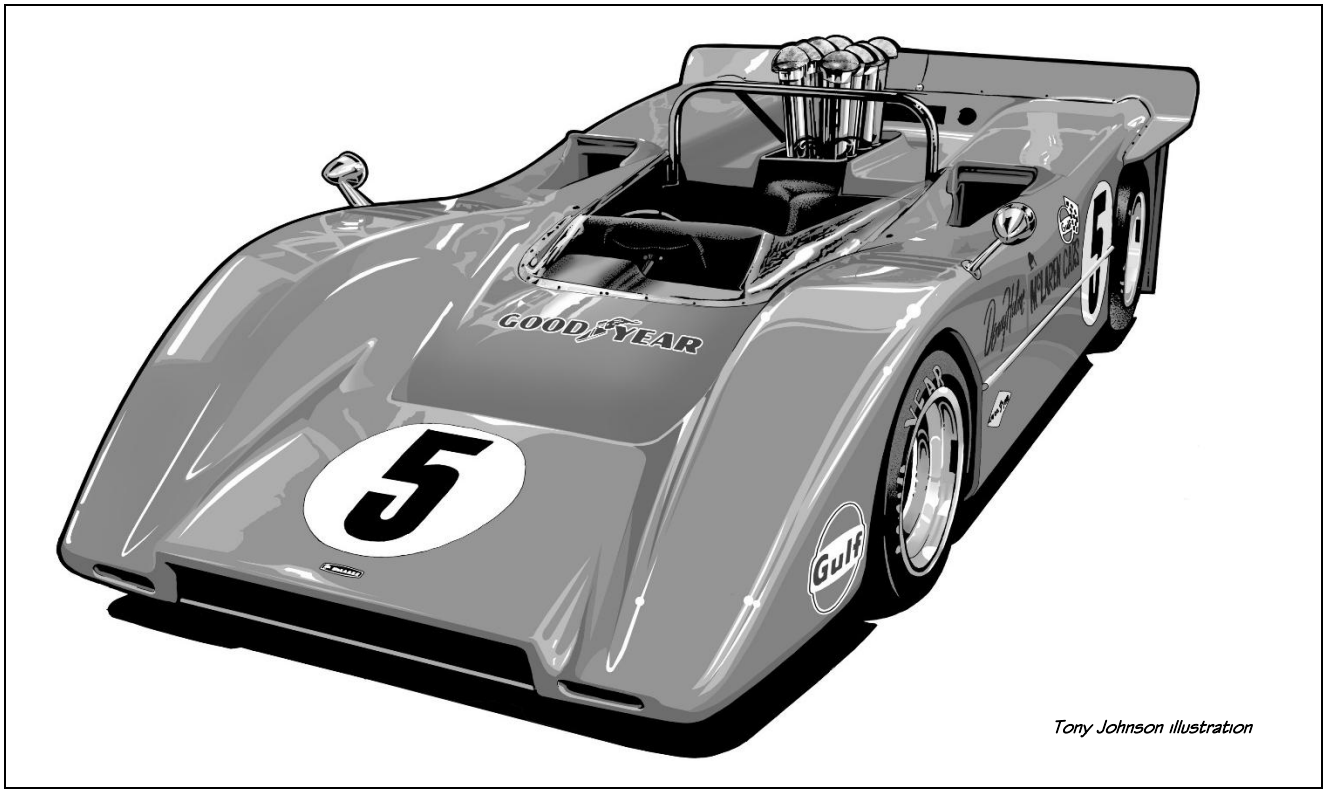
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Tony Johnson Illustration

CHAPTER 11 (PART 1): EXHAUST NOISE EMISSIONS

Introduction

The purpose of this chapter (Part 1) is to specify a set of technical requirements, together with an associated testing process, for measuring exhaust noise emissions – known as 'objective noise testing', or 'ONT'. The chapter provides a test method and procedure that has been developed by LVVTA, derived from international best-practice, which is applied in controlled conditions, and will result in accurate, repeatable, and legally defensible outcomes.

Note that where a vehicle is fitted with its original unmodified exhaust system, the requirements in this chapter do not apply, provided that the vehicle has not been 'green-stickered' or 'pink-stickered' for emitting excessive noise.

General Safety Requirements

11.0 Suitability and Condition

11.0.1

An exhaust system fitted to a low volume vehicle must be:

(a) of a good design using materials suitable for the purpose; and

(b) in good condition and free of leaks; and

(c) securely attached to the vehicle, using a mounting system that enables all necessary engine movement without stressing the exhaust system.

11.0.2

The body of a low volume vehicle must, in the areas adjacent to the vehicle's exhaust system, be sufficiently sealed so as to prevent the entry of any exhaust gases into the passenger compartment.

Exhaust System Design Requirements

11.1 Exhaust System Interference

11.1.1

An exhaust system fitted to a low volume vehicle must be designed, constructed, and fitted in such a way that:

(a) the exhaust system, or components within the exhaust system, cannot be removed, altered, or interfered with, without the use of hand tools; or

(b) the performance or operation of the exhaust system cannot be altered from inside the vehicle, or whilst the vehicle is in motion, in such a way that the decibel levels specified in 11.22 are exceeded, unless the vehicle is fitted with such a system as original equipment to the vehicle in question by a production vehicle manufacturer.

11.1.1(b)

This means that a multi-mode exhaust system cannot be designed into a scratch-built vehicle or retro-fitted into a modified production vehicle, unless the maximum permissible decibel levels in 11.22 are not exceeded in any available mode.

11.2 Exhaust System Protection & External Projections

11.2.1

Sections of an exhaust system which extend beyond the outer longitudinal extremity of the vehicle, or the outer sidewall of the tyres, must:

(a) not present any sections of open exhaust tubing or sharp edges facing toward the front of the vehicle; or

(b) have any sections of exposed exhaust adjacent to points of occupant entry and exit adequately heat-shielded, to prevent burn injuries in the event of being contacted by an occupant entering or exiting the vehicle.

11.3 Exhaust System Positioning

11.3.1

An exhaust system fitted to a low volume vehicle must be positioned so that it:

(a) is isolated from the passenger compartment; and

(b) terminates in a position where the outer end of the exhaust pipe is not directly underneath the passenger compartment.

Testing Requirements

11.4 Test Site Requirements

11.4.1

A test site used in the application of this chapter must be an open outdoor site that:

(a) is predominantly flat, particularly within the immediate test area; and

(b) incorporates within a radius of not less than 3 metres (10 feet) from the sound level meter microphone:

(i) a space free from large sound-reflecting surfaces including buildings, walls, billboards, vehicles, trees, or shrubs; and

(ii) a solid surface such as concrete or asphalt, free of any loose or sound-absorbing material.

11.4.2

Exhaust noise emission testing on a low volume vehicle may be carried out under a canopy, provided that no part of the canopy, including its supports, are within 3 metres (10 feet) of the sound level meter microphone.

11.4.1 & 11.4.2

Accurate and repeatable exhaust noise emission test results can only be obtained by using a large space with a solid ground surface like a big car park, with no sound reflecting surfaces.

11.5 Field Calibrator Requirements

11.5.1

A field calibrator used in the application of this chapter must be:

(a) specifically approved and issued for that purpose by LVVTA; and

(b) in good operating condition; and

(c) re-calibrated by an approved calibration laboratory at intervals specified by LVVTA.

11.5.1(c) & 11.6.1(c)

As a general rule, calibration intervals for field calibrators and sound level meters will be as specified by the equipment manufacturer, in accordance with ISO Standard 5130:2007.

The process of collection, re-calibration, and re-issue of the field calibrators and sound level meters will be arranged by LVVTA.

11.6 Sound Level Meter Requirements

11.6.1

A sound level meter used in the application of this chapter must be:

(a) a Class-1, Type-0 or Type-1 meter, specifically approved and issued for that purpose by LVVTA; and

(b) in good operating condition; and

11.6.2

The use of a Type-2 sound level meter is strictly limited to preliminary 'quick-check' work. This reduces costs and inconvenience to the vehicle owner leading up to the full test, so that the likelihood of a 'pass' when applying the full test is maximised.

(c) re-calibrated by an approved calibration laboratory at intervals specified by LVVTA.

11.6.2

An LVV Certifier may use a Type-2 sound level meter in conjunction with the test process prescribed by this chapter, provided that the Type-2 sound level meter is:

(a) used only for the purpose of establishing a vehicle's approximate exhaust noise level prior to a full test conducted in accordance with this chapter being carried out; and

(b) specifically approved and issued for that purpose by LVVTA; and

(c) in good operating condition.

11.6.2 (cont'd)

No written approval may be provided by an LVV Certifier through the use of a Type-2 meter, or a 'quick check' process, unless it is for the purpose of informing an Authorised Vehicle Inspector (AVI) that a vehicle which has failed a WoF for exhaust noise clearly passes.

11.7 Tachometer Requirements

11.7.1

A tachometer used in the application of this chapter must where practical, be proven by calibration to be within +/- 2% accuracy, and be:

(a) specifically approved and issued for that purpose by LVVTA; and

(b) in good operating condition.

11.7.1

An approved tachometer may be used either as a means by which to measure engine speed during the exhaust noise emission test, or as a means by which to verify the vehicle's original equipment tachometer.

11.7.2

A tachometer used in the application of this chapter may be either:

(a) a calibrated remote inductive pick-up tachometer issued by LVVTA; or

(b) where a tachometer specified in 11.7.1 will not enable a reliable engine speed reading to be received due to the type of ignition system used within the vehicle, a calibrated infra-red tachometer issued by LVVTA; or

(c) where neither tachometer specified in 11.7.1 nor 11.7.2 will enable a reliable reading to be received, the vehicle's original equipment tachometer or other trusted engine speed measurement device.

11.7.2(b)

An infra-red meter will almost always read the engine speed from a bold white marking or piece of reflective tape placed on the engine's crankshaft pulley. This option however, may necessitate an assistant to help the LVV Certifier.

11.7.2(c)

In cases where the supplied tachometers are not suitable and the vehicle is not equipped with a tachometer, in the interests of completing the test, the LVV Certifier may elect to use an alternative engine speed measurement device that is known to have good accuracy, such as a suitably equipped professional timing light or automotive multi-meter with inductive input.

Engine Speed Selection Requirements

11.8 Determining applicable engine speed

11.8.1

The applicable engine speed used during an exhaust noise emission test must be within a tolerance of +/- 5% of either:

(a) in the case of an engine that has a manufacturer's engine speed maximum power (ESMP) that is known to the LVV Certifier, 75% of that figure; or

(b) in the case of an engine that does not have a manufacturer's ESMP that is known to the LVV Certifier, or the manufacturer's ESMP has become irrelevant because the engine is now outside of its original specification:

(i) 4500 RPM if the engine is a rotary engine; or

(ii) 4000 RPM if the engine has five or less cylinders; or

(iii) 4800 RPM if the engine has five or less cylinders and is of a double over-head camshaft and variable valve timing engine design; or

(iv) 3200 RPM if the engine has six cylinders; or

(v) 3000 RPM if the engine has eight cylinders; or

(vi) 4000 RPM if the engine has more than eight cylinders; or

(vii) 2500 RPM if the engine is a diesel engine;

or

(c) in the case where an LVV Certifier believes the engine speeds specified in 11.8.1(b) are unreasonably high, taking into account the type and age of the engine, they may apply an engine speed for the purpose of the sound level test at which they believe is appropriate for the engine, and at which the engine may be safely operated.

Vehicle Preparation Requirements

11.9 Operating Temperature

11.9.1

The engine in a low volume vehicle which undergoes an exhaust noise emission test, must, prior to the commencement of the test, be brought up to normal operating temperature.

11.10 Positioning

11.10.1

A low volume vehicle which undergoes an exhaust noise emission test must be positioned centrally within a test site that meets the requirements specified in 11.4, and must:

(a) be stationary; and

(b) have the parking brake applied; and

(c) have the gear selector positioned either:

(i) in the case of a manual transmission-equipped vehicle, in neutral; or

(ii) in the case of an automatic transmission-equipped vehicle, in park;

and

(d) have the air conditioning system, if fitted, turned off; and

(e) have the engine hood, if fitted, closed.

11.10.1(c)(ii)

Where a vehicle has a built-in rev-limiter that does not allow the engine speed required in 11.8.1(b) to be reached in park, the shifter may need to be moved to the neutral position, or the vehicle may need to be put in a service or maintenance mode electronically.

11.11 External Noise Sources

11.11.1

In a case where it is believed that one or more noises emitted by the vehicle, other than exhaust outlet noise, is adversely influencing the total noise recorded, the exhaust outlet noise may be isolated from the other noise sources by using shielding around the vehicle, providing that the shielding material:

(a) is not within 50 mm of the exhaust outlet; and

(b) does not obstruct the clear path between exhaust outlet and microphone position.

11.11.1

Suitable shielding may include acoustic partitions, layers of fibre 'batts' insulation, or sand-bags. Care must be taken to avoid the risk of combustion of shielding material.

Test Procedure Requirements

11.12 Background Noise Testing

11.12.1

The combination of wind or other background noise present at an exhaust noise emission test, if any, must:

(a) be at least 10 dBA below the sound level of the vehicle being tested; and

(b) be measured both prior to, and after the completion of, the exhaust noise emission test process.

11.12.1

Wind can cause high readings to be displayed on a sound level meter, and consistent vehicle noise measurements cannot be made when wind is affecting the readings. By meeting the requirements specified in 11.12.1, any additional noise caused by wind and any other sources producing background noise will not adversely affect the exhaust noise emission testing outcome.

11.13 Field Calibration Checking

11.13.1

A sound level meter used in the application of this chapter must, before and after each exhaust noise emission test:

(a) undergo a field calibration check against a field calibrator issued by LVVTA; and

(b) record a difference between the two checks of not more than 0.5 dBA.

11.13.1

If more than 0.5 dBA difference is recorded between the two calibration checks, the test must be disregarded and carried out again.

11.14 Microphone Set-up and Positioning

11.14.1

The sound level meter microphone, when testing a low volume vehicle for exhaust noise emissions, in all cases, including those specified in 11.15.1 to 11.17.1, must:

(a) be protected by a foam wind-shield at all times during the noise emission test set-up and testing process; and

(b) be positioned at (see Diagrams 11.1 and 11.2):

(i) a distance from the exhaust outlet of 500 mm (+/- 10 mm), except where the vehicle meets the criteria specified in 11.16.2; and

(ii) an angle of 45 degrees (+/- 5 degrees) to the direction of gas flow, always using the position furthest from the vehicle's longitudinal centreline; and

(iii) the same height as the exhaust outlet, however not closer to the ground than 200 mm.

11.14.1

Where a vehicle's exhaust outlet is closer to the ground than 200 mm, the microphone must be positioned no lower than 200 mm from the ground. This is in order to avoid 'sound bounce' affecting the test results.

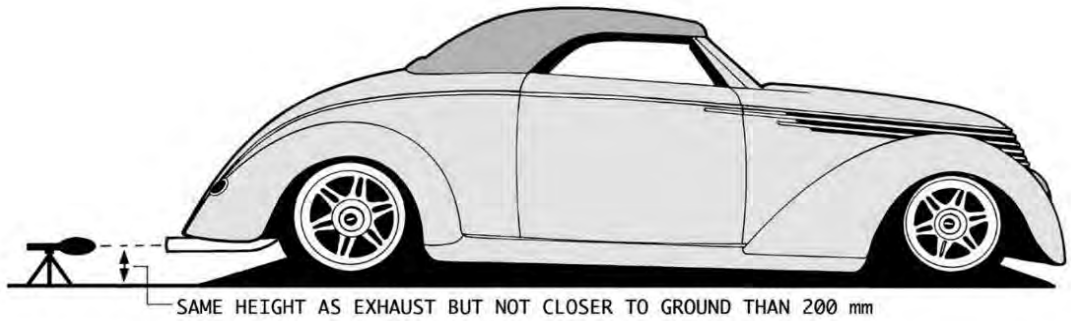


Diagram 11.1 Microphone Positioning for Single Exhaust Outlet (Side View)

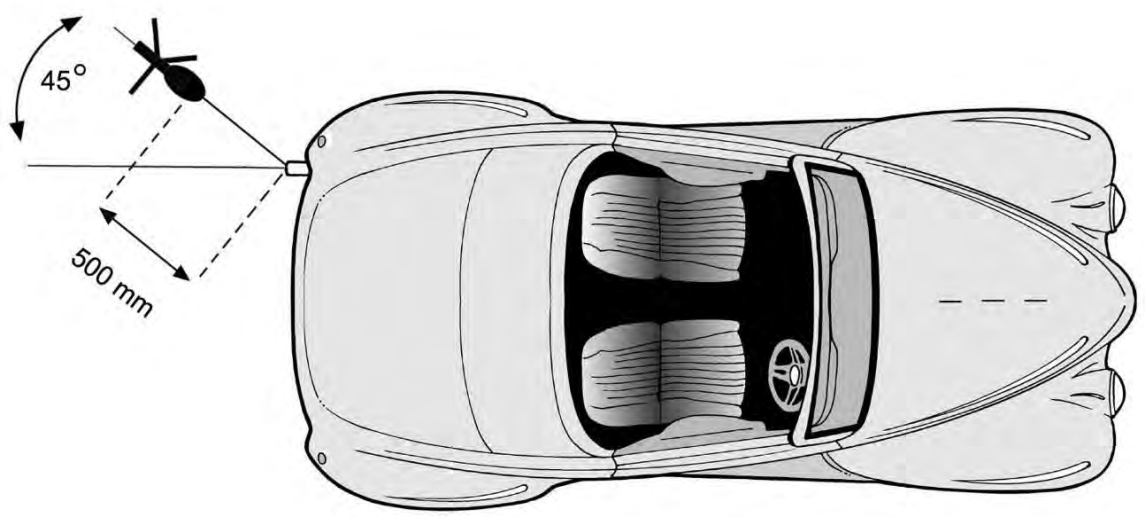


Diagram 11.2 Microphone Positioning for Single Exhaust Outlet (Plan View)

11.15 Microphone Positioning with Two Exhaust Outlets

11.15.1

In the case of a low volume vehicle with two exhaust outlets, and the two outlets are less than 300 mm apart, the outlets must be treated as one and measured together, with the sound level meter microphone positioned at the exhaust outlet that is furthest from the vehicle's longitudinal centreline.

11.15.2

In the case of a low volume vehicle with two exhaust outlets, and the two outlets are more than 300 mm apart (see Diagram 11.3), the outlets must be treated as two separate outlets and measured individually, with the figure from the loudest outlet taken as the result.

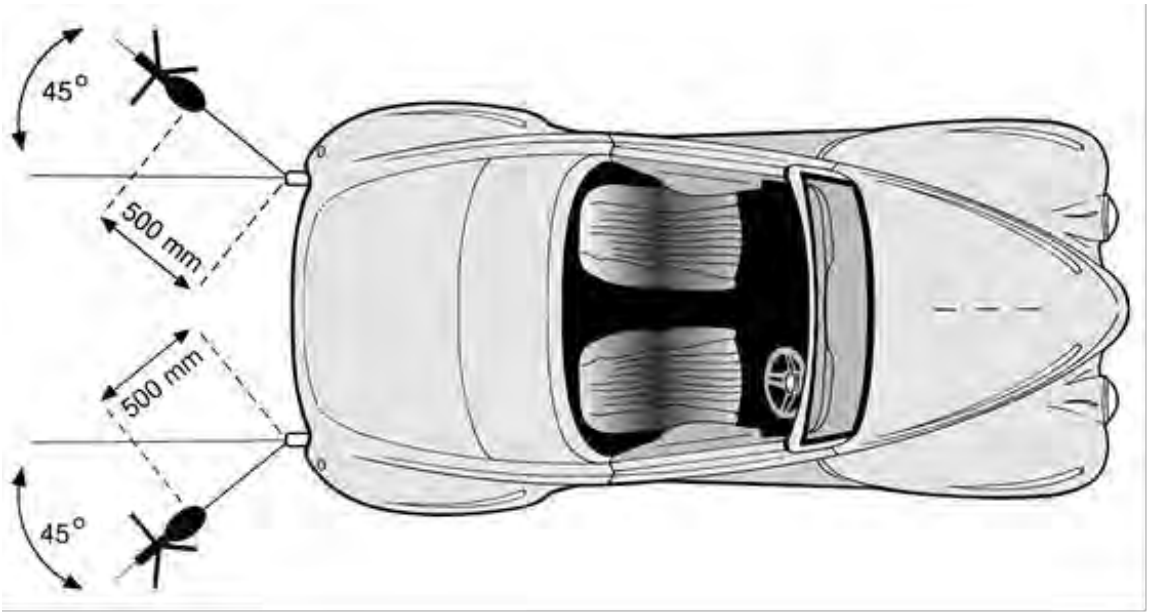


Diagram 11.3 Microphone Positioning for Twin Exhaust Outlets

11.16 Microphone Positioning with Other Unusual Outlets

11.16.1

In the case of a low volume vehicle that has an exhaust outlet located at an angle to the vehicle's longitudinal centreline, the sound level meter microphone must be positioned at the point which is furthest from the engine (see Diagram 11.4).

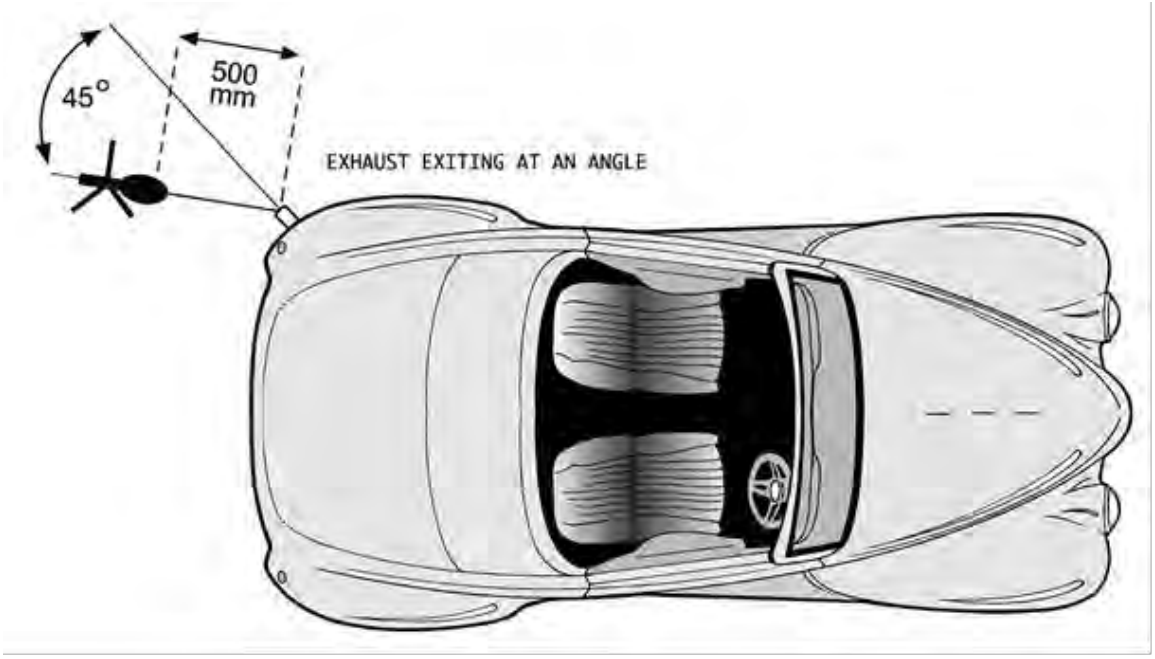


Diagram 11.4 Microphone Positioning for Angled Exhaust Outlets

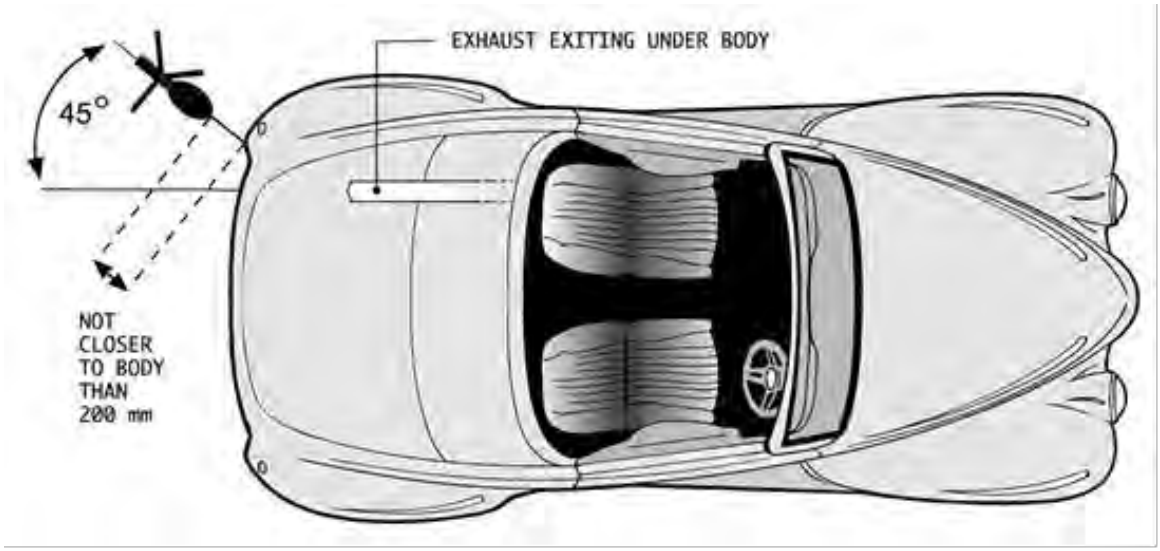


Diagram 11.5 Microphone Positioning for Exhaust Outlets that Terminate Under Vehicle Body

11.16.2

In the case of a low volume vehicle that has an exhaust outlet that terminates under the vehicle body, the sound level meter microphone must be positioned as closely as practical to the outlet, however the sound level meter microphone must not (see Diagram 11.5):

(a) be positioned any closer to the vehicle body than 200 mm; and

(b) have any part of the vehicle obstructing a clear path between it and the exhaust outlet, and may, in order to achieve a clear path, be positioned at less than 45 degrees to the direction of gas flow, provided that the sound level meter microphone is no closer to the exhaust outlet than 500 mm.

11.16.2

The microphone must never be positioned closer to the vehicle body than 200 mm. This is in order to avoid 'sound bounce' affecting the test results.

For other positions not described in this chapter, such as a vertical stack, an LVV Certifier should seek advice from LVVTA.

11.17 Testing Multi-mode Exhaust Systems

11.17.1

In the case of a low volume vehicle that is fitted with a multi-mode exhaust system and a manual exhaust control, the exhaust noise emission test must be carried out with the mode switch in all positions, with the highest sound level recorded taken as the test figure.

11.18 Sound Level Meter Setting

11.18.1

When testing a low volume vehicle for exhaust noise emissions:

(a) the sound level meter microphone must be self-supported; and

(b) the sound level meter must be set at:

  (i) 'curve-A' or 'A-weighted' sound pressure level; and

  (ii) 'fast response', or 'time weighting F'.

11.19 Sound Level Meter Activation and Recording

11.19.1

During exhaust noise emission testing on a low volume vehicle, no person may be present within a radius of 3 metres (10 feet) of the vehicle undergoing sound level testing, other than:

(a) the LVV Certifier; and

(b) if required, one additional person appointed by the LVV Certifier to assist with the exhaust noise emission test.

11.19.2

During exhaust noise emission testing of a low volume vehicle, the sound level meter must record the exhaust noise level held constantly for a period of not less than one second at the selected engine speed specified in 11.8.1(b) and throughout the deceleration period back to idle.

11.20 Interpretation of Sound Level Test Results

11.20.1

The figure recorded for each exhaust noise emission test of a low volume vehicle must be to one decimal point.

11.20.2

The result of an exhaust noise emission test of a low volume vehicle must be calculated from the average of three separate and consecutive measurements, each of which must be within 2 dBA of each other.

11.20.3

The final decibel figure established for a low volume vehicle after an exhaust noise emission test, and application of any applicable factoring specified in 11.22, must be rounded to the nearest whole dBA value.

11.20.4

An unusual or unrelated noise spike or peak that occurs when carrying out an exhaust noise emission sound level test on a low volume vehicle must not be taken into account as part of the test results, in which case the test must be repeated until a satisfactory result is achieved.

Decibel Level Requirements

11.21 Decibel Limits

11.21.1

The maximum permissible decibel level emitted by a low volume vehicle tested in accordance with this chapter, must not, except for in the case of where factoring must be applied for one or more of the situations specified in 11.22.1 to 11.22.3, exceed:

(a) in the case of an MA, MB, MC, MD1, MD2, or NA-class vehicle that was manufactured before 1 January 1985, 95 dBA; or

(b) in the case of an MA, MB, MC, MD1, MD2, or NA-class vehicle that was manufactured on or after 1 January 1985:

  (i) if first registered in New Zealand before 1 June 2008, 95 dBA; or

  (ii) if first registered in New Zealand on or after 1 June 2008, 90 dBA.

11.19.2

The standardised test process for sound level meter activation and recording must incorporate the following steps:

- adjust the throttle to bring the engine speed up to the selected level;
- begin recording noise output;
- hold the engine speed for at least one second;
- release the throttle and allow the engine speed to fall naturally back to idle;
- once at idle, stop recording noise output.

11.20.4

A noise spike or peak does not include an exhaust over-run 'boom', but rather is intended to apply to unusual or intermittent one-off sounds unrelated to the exhaust noise from the surrounding environment, such as a loud bang, aircraft flying past, or a barking dog.

Rattling noises such as those made at certain engine speeds by number plates or non-exhaust heat-shields during the test can also cause an unwanted spike or peak.

11.22 Decibel Factoring for Specific Situations

11.22.1

A factor of 4 dBA may be subtracted from the average decibel level recorded in 11.21.1, in order to compensate for the increased background noise caused by the close proximity of the engine to the exhaust outlet, in the case of a low volume vehicle that has either:

(a) the engine positioned to the rear of the driver; or

(b) the exhaust outlet positioned within 1.5 metres (5 feet) of the engine.

11.22.2

A factor of 2 dBA may be subtracted from the average decibel level recorded in 11.21.1, in the case of a low volume vehicle that has the factor specified in 11.22.1 already applied, which incorporates a particular type of engine, or engine equipment or components, that emits an unusually high level of mechanical sound, if the LVV Certifier believes that the exhaust noise emission figure may be influenced by that engine type, equipment, or components.

11.22.3

A factor of 5 dBA may be subtracted from the average decibel level recorded in 11.21.1, in the case of a scratch-built low volume vehicle of scratch-built sub-category 'Historic Replica', or scratch-built sub-category 'Reproduction', first registered in New Zealand on or after 1 June 2008, that is a replication or reproduction of a vehicle manufactured before 1 January 1985.

Reporting Requirements

11.23 Required Information

11.23.1

The information that must be recorded and provided when performing an exhaust noise emission test on a low volume vehicle is:

(a) the make, model, year, and VIN of the vehicle to which the exhaust noise emission test has been applied; and

(b) the location of the test site; and

(c) the make, model, and serial number of the sound level meter used; and

(d) the background noise level measured before and after the tests; and

11.21.1

These decibel figures are set by the Government, as specified in *Land Transport Rule: Vehicle Equipment 2004*, and may change from time to time as Government policy dictates. Any such changes will be reflected in an amendment to this chapter.

See the Terms & Definitions section at the back of this chapter for information about 'dB' and 'dBA.

11.22.1 & 11.22.2

In a case where shielding around the vehicle is used as described in 11.11.1, the decibel factoring noted in 11.22.1 and 11.22.2 cannot be applied.

11.22.2

A diesel engine or an air-cooled engine are typical examples, and the components or equipment referred to may include cooling fans, mechanical belt-driven superchargers, gear-driven camshafts and balance shafts, belt-driven primary drives, and dry clutches.

In order for such components to have an influence on the exhaust noise emission testing, it will generally either have no effective shielding surrounding it, or be positioned within two metres (six feet) of the sound level meter microphone.

(e) the selected engine operating speed used for the test; and

(f) the applicable decibel limit from 11.21.1 that applies to the vehicle for the test; and

(g) a clear indication of whether the subject vehicle has passed the test; and

(h) reference to this chapter; and

(i) a detailed description of the subject vehicle's exhaust system, which records the length, diameter, type, and material of the various components used within the system, and the basic shape, configuration, and positioning of the system.

11.24 Required Photographs

11.24.1

Clear, high-resolution photographs must be taken and provided when performing an exhaust noise emission test on a low volume vehicle of:

(a) the vehicle's exhaust system, including the components listed in 11.23.1(i); and

(b) the vehicle's manufacturer-assigned chassis number or NZTA-assigned VIN; and

(c) the LVV Electronic Data Plate once affixed to the vehicle, with its number clearly visible; and

(d) the LVV Electronic Data Plate, showing the location of its fitment on the vehicle.

11.24.1(a)

For the sake of clarity, the photographs are only intended to record the exhaust system as it was at the time the ONT was carried out, and to identify the location of the EDP on the vehicle. These do not imply any kind of assessment, approval, or LVV certification of any other modifications.

Exclusions

No exclusions apply to this chapter.

Useful Information

Challenges for older vehicles

The more modern a vehicle is, the greater the level of silencing technology that is incorporated within the vehicle, because:

- newer engines feature improved silencing technology within the engine design; including block, cylinder head, component materials, casting techniques, water-jacket positioning, induction system design, and cooling fan and ancillary equipment design;
- silencer technology has improved over time;
- the presence of catalytic converters in modern cars reduces exhaust noise emissions even further.

Applying modern decibel limits to old vehicles can be challenging for many reasons, including that:

- as noted above, older engines generally emit more mechanical noise;

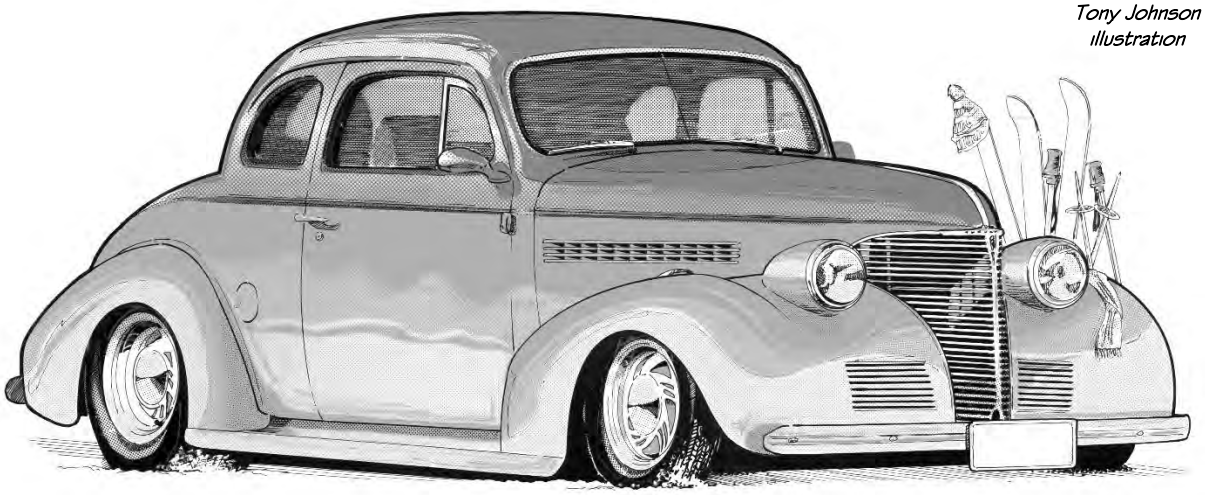
- many older vehicles that are modified have larger capacity engines, which are inherently more difficult to silence;
- pre-1940s body styles are less effective at containing the engine noise, as they incorporate openings in the engine hoods and side-panels to assist with cooling, which has the effect of increasing the amount of engine noise that can be heard from outside the vehicle;
- some very old vehicles (especially 1920s and early 1930s vehicles) are unusually short, which provides less length for an exhaust system.

Terms & Definitions for Chapter 11 - Exhaust Noise Emissions

AVI	(Authorised Vehicle Inspector) means a person who carries out WoF inspections on behalf of NZTA.
A-weighted decibels	means an adjustment to measured or calculated sound pressure levels that accounts for the varying sensitivity of human hearing to sound at different frequencies.
Aftermarket	means a component or system made by a manufacturer, other than a high-volume motor vehicle manufacturer, who produces components or systems on a production-run basis for the mass-market.
Automatic transmission	means a type of gearbox, or transmission, which automatically varies the ratios between the input shaft and the output shaft to suit engine speeds automatically, without the driver having to physically select the gears.
Class	(also known as Type) in relation to a sound level meter, describes its accuracy as defined by the relevant international standards. The ANSI S1.4 and older IEC 60651 standards refer to the level of accuracy as 'Type', whereas the new standard IEC 61672 refers to the level of accuracy as 'Class'.
dB	(decibel) means a logarithmic measurement unit that describes a sound's relative loudness, though it can also be used to describe the relative difference between two power levels. In sound, decibels generally measure a scale from 0 (the threshold of hearing) to 120-140 dB (the threshold of pain). A 10 dB difference is required to double the subjective volume. Generally, if the distance from the noise source is doubled, the noise level will be 6 dB lower. A 2-3 dB difference over a broad frequency range is noticeable to most people.
dBA	(decibel) means A-weighted decibels, which is an adjustment process that takes into account the varying sensitivity of the human ear, to different decibel levels at different frequencies. Low frequency sounds are quieter to the human ear. The 'A' weighting curve primarily takes into account the 500-10,000 Hz frequency range.
ESMP	(Engine Speed at Maximum Power) means a specified engine speed applicable to the particular make and model of engine, when carrying out an ONT.
Heat shield	means a heat-resistant piece of material placed between a heat-generating component and a heat-sensitive component, to prevent or minimise heat transfer from one to the other.
Hz	(Hertz) means cycles per second.
L-class	is an NZTA classification, which means, in very simple terms, a two-wheeled motorcycle or three-wheeled motor vehicle with a GVM of under 1000 kg.

LVV	(Low Volume Vehicle) means, in simple terms, LVVs which are modified or scratch-built in small numbers, and includes individually modified or scratch-built LVVs. The full definition of an LVV is contained in the *LVV Code*.
LVV Certifier	(Low Volume Vehicle Certifier) means a person appointed by NZTA under the provisions of *Land Transport Rule: Vehicle Standards Compliance 2002*, to carry out low volume vehicle certification of modified and scratch-built LVVs, as specified by *Part 2* of the *LVV Code*.
LVV Code	(Low Volume Vehicle Code or the Code) means an LVVTA document which is incorporated by reference into the *Land Transport Rule: Vehicle Standards Compliance 2002*, and all applicable individual *Land Transport equipment rules*, that provides the legal framework to enable the LVV certification of modified and scratch-built LVVs in New Zealand.
LVVTA	(Low Volume Vehicle Technical Association) is an incorporated society comprised of specialist vehicle associations. Established in 1992, its objectives are to represent the interests of vehicle modifiers and builders in New Zealand, and to ensure high safety standards for modified and scratch-built LVVs. The LVVTA owns and administers the *LVV Code*.
Modification	is defined in *Land Transport Rule: Vehicle Standards Compliance 2002*) to change a vehicle from its original state by altering, substituting, adding or removing any structure, system, component or equipment, but does not include repair. 'Modified' and 'modification' have corresponding meanings.
Modified Production (LVV)	means, in simple terms, a vehicle which, while modified, maintains a sufficient percentage of body or chassis from one primary mass-produced vehicle that it can still be considered to be that vehicle. The full legal definition of a Modified Production LVV is complex and currently under review, and will be incorporated within the *LVV Code* once revised.
Motorcycle	means a vehicle of Table-A class LA, LB, LC, LD, and LE, as defined in *Land Transport Rule: Vehicle Standards Compliance 2002*.
Muffler	means a device for reducing the noise of the exhaust gases before they are released into the air through the tailpipe.
NZTA	(New Zealand Transport Agency) is a Crown entity responsible for managing New Zealand's land transport system.
Passenger compartment	means the part of a motor vehicle body that houses the passengers and driver.
RPM	(revolutions per minute) means the number of times an engine's reciprocating assembly turns in one minute.
Scratch-built (LVV)	means, in simple terms, an LVV which has been individually constructed from unrelated components, or a mass-produced vehicle which has been modified to such an extent that it can no longer be considered to be a modified mass-produced vehicle. The full legal definition of a scratch-built LVV is currently under review, and will be incorporated within the *LVV Code* once revised.
Scratch-built Historic Replica (LVV)	means a sub-category of scratch-built low volume vehicle, as defined in *Chapter 2 - LVV Classifications* of the *LVV Operating Requirements Schedule*.
Scratch-built Reproduction (LVV)	means a sub-category of scratch-built low volume vehicle, as defined in *Chapter 2 - LVV Classifications* of the *LVV Operating Requirements Schedule*.

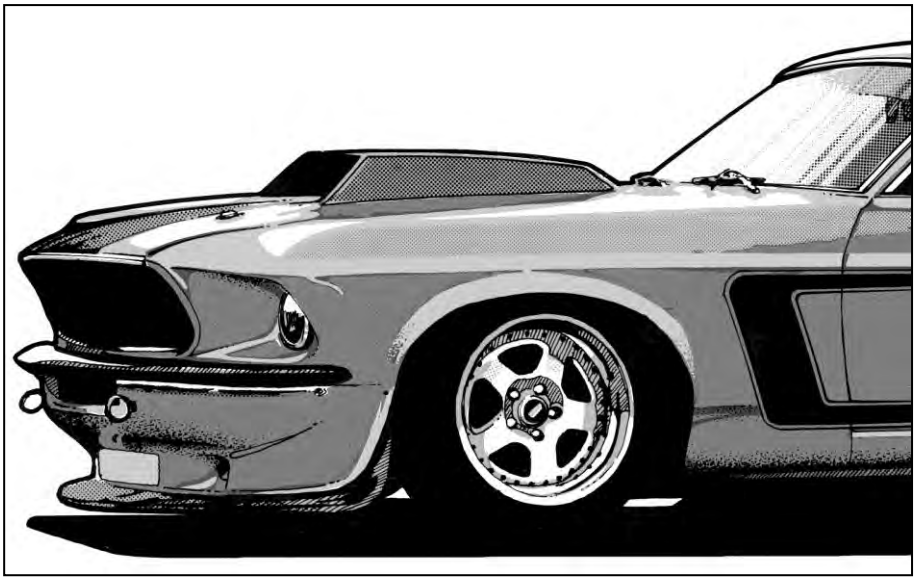
Sound level meter	means a device for measuring the level of sound output, in decibels, when carrying out an ONT.
Tachometer	means an instrument by which the rotational speed of an engine is measured.
WoF	(Warrant of Fitness) means a safety inspection and approval process for in-service vehicle, issued by an NZTA-appointed AVI.



Tony Johnson illustration

Chapter 12:

WHEELS & TYRES



TJ illustration

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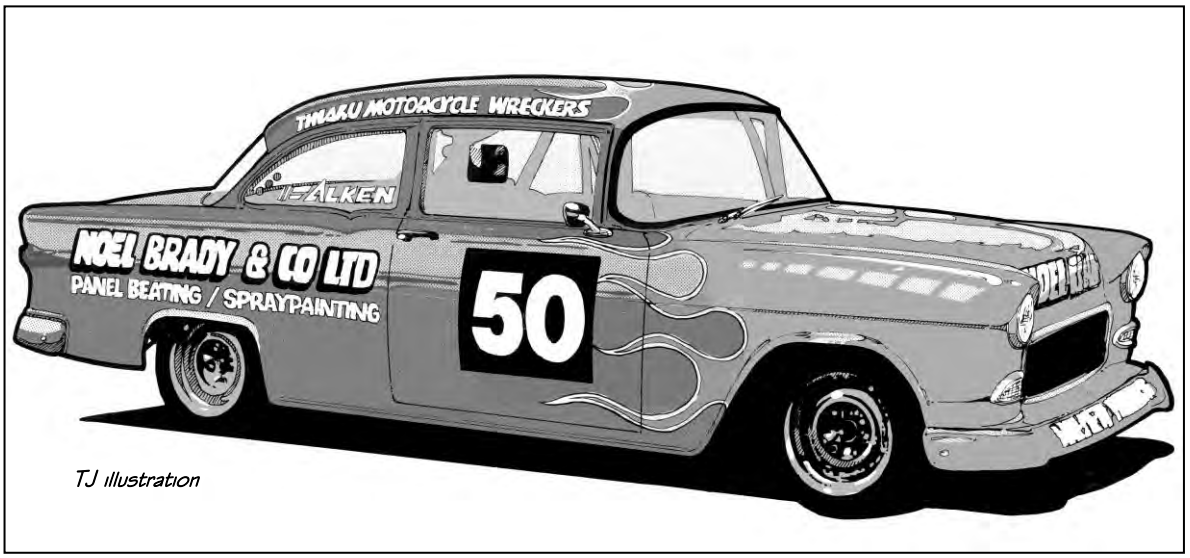
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Key: (for full key details, refer to 'Chapter 2 – About this Manual')
Normal type: Provisions of the NZ Car Construction Manual for all vehicles
Normal type in shaded box: Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates
Italic type: *Extracts from any relevant LVVTA Low Volume Vehicle Standards*
Script type: Helpful hints, tips, explanations, clarifications, and interpretations
Shaded text & dotted vertical stroke in margin: Latest amendments since previous version



TJ illustration

CHAPTER 12: WHEELS & TYRES

Introduction:

The three key ingredients to the successful visual outcome of any hobby car, particularly within hot rodding, is stance, colour, and wheels and tyres. However, this is an area where focusing on form without giving due consideration to function, can have long-lasting negative effects on the way a hobby car rides and handles. If proper thought and attention is paid to the technical requirements in this chapter, that all important look can be achieved whilst still ending up with a vehicle that offers as much comfort and handling as it does eye-candy.

Note that where a production vehicle is fitted with its original wheels and tyres, the requirements in this chapter do not apply.

Wheel suitability requirements:

12.1 Wheel compatibility

12.1.1

Each pair of front wheels, or rear wheels, fitted to a low volume vehicle, must be of the same width, diameter, mounting configuration, and offset.

12.2 Wheel loading

12.2.1

A wheel fitted to a low volume vehicle must be:

(a) *purpose-designed for automotive road use;*

and

(b) *designed to withstand:*

(i) *the combination of vehicle weight and vehicle load weight; and*

(ii) *the cornering and braking forces applied by the motion of the vehicle.*

12.2.1(b)

Wire spoke wheels shouldn't be used on high horsepower vehicles, or vehicles designed to achieve high cornering loads.

12.2.2

A wheel that is manufactured by a high volume motor vehicle manufacturer, must not be fitted to a low volume vehicle that has a higher tare, or gross vehicle mass, than the vehicle to which the wheel was originally fitted.

12.2.2

See the 'Terms and Definitions' at the back of this manual for definitions on 'tare' and 'gross vehicle mass'.

12.2.3

A wheel fitted to a low volume vehicle must be thoroughly visually inspected to ensure that;

(a) *the design and the strength of the wheel appears consistent with the common time-proven makes; and*

(b) *there is no evident deterioration or cracking, particularly around wheel attachment points; and*

12.2.3(b)

Old steel wheels in particular should be inspected on the outside of the rim (with tyre removed) to ensure that the wheel has not been weakened by rust.

(c) *the wheel is of an appropriate size for use with the weight and performance characteristics of the vehicle to which it is fitted.*

12.3 Wheel width

12.3.1

A wheel fitted to a low volume vehicle, must be of a width, measured between tyre bead seats, of not less than:

Wire spoke wheels should be inspected to ensure that all spokes are tight.

(a) *in the case of a low volume vehicle other than one specified in 12.3.1(b), 114mm (4 ½"); or*

(b) *in the case of either:*

(i) *a light-weight low volume vehicle based on a pre-1960 vintage, sports, or period special body style, 88 mm (3 ½"); or*

(ii) *an unusually light-weight low volume vehicle that has a tare of 500 kg (1100 lb) or less, not less than that which can be proven to be of adequate load rating for the application.*

12.4 Safety bead swages

12.4.1

A wheel fitted to a low volume vehicle, must be either:

(a) *of a type which incorporates double-sided safety bead swages; or*

(b) *fitted with an inner tube which is compatible with the tyre to which it is fitted.*

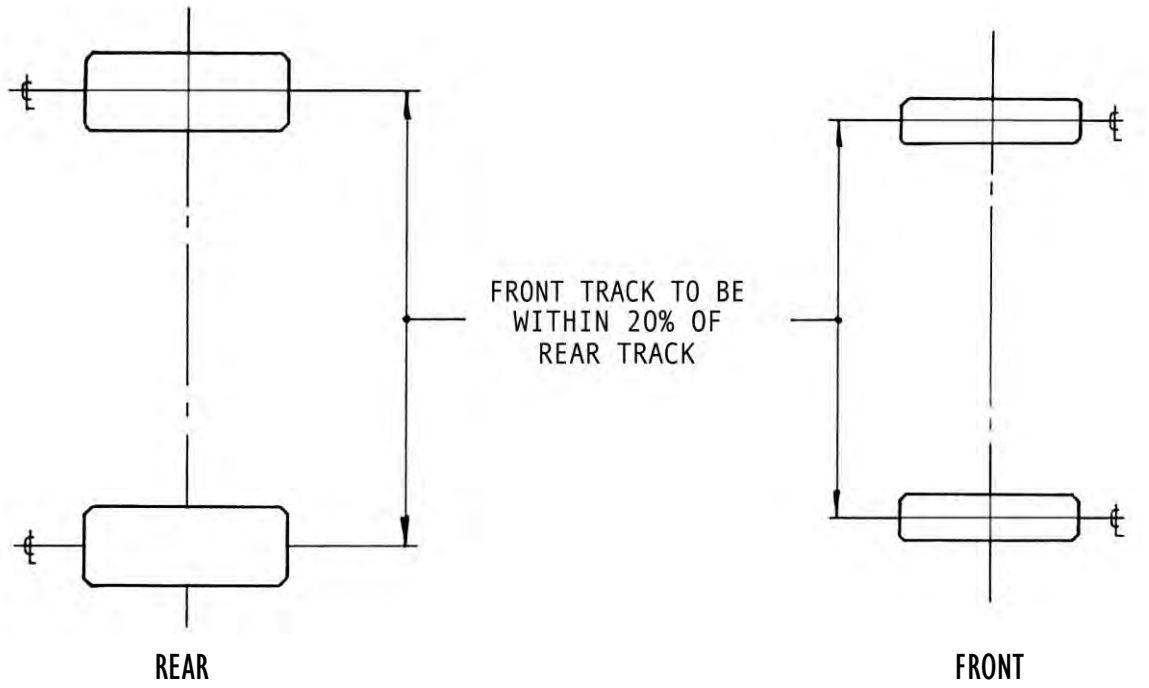
12.4.1

Wheels without safety bead swages should not be used in high-performance applications, especially in vehicles designed to achieve high cornering loads.

12.5 Wheel track

12.5.1

A low volume vehicle that has four wheels and tyres, must have a front wheel track, measured from centre to centre of the tyre treads, that is within 20% of the rear wheel track. (see Diagram 12.1)



GW diagram

Diagram 12.1 Wheel track

12.6 Wheel offset

12.6.1

The wheel offset on a wheel fitted to a low volume vehicle, other than a vehicle specified in 12.6.1(b), measured from hub flange to wheel width centre-line, including any spacers or adaptors if fitted, must be either: (see Diagram 12.2)

(a) *no more than 35% of the total wheel width positive or negative; or*

(b) *in the case of an offset outside of the requirements specified in 12.6.1(a), either:*

(i) *the axle and hub components used are from a vehicle which is substantially heavier than the vehicle to which the suspension and axle componentry is now fitted; or*

(ii) *a fully-floating hub and axle assembly is used.*

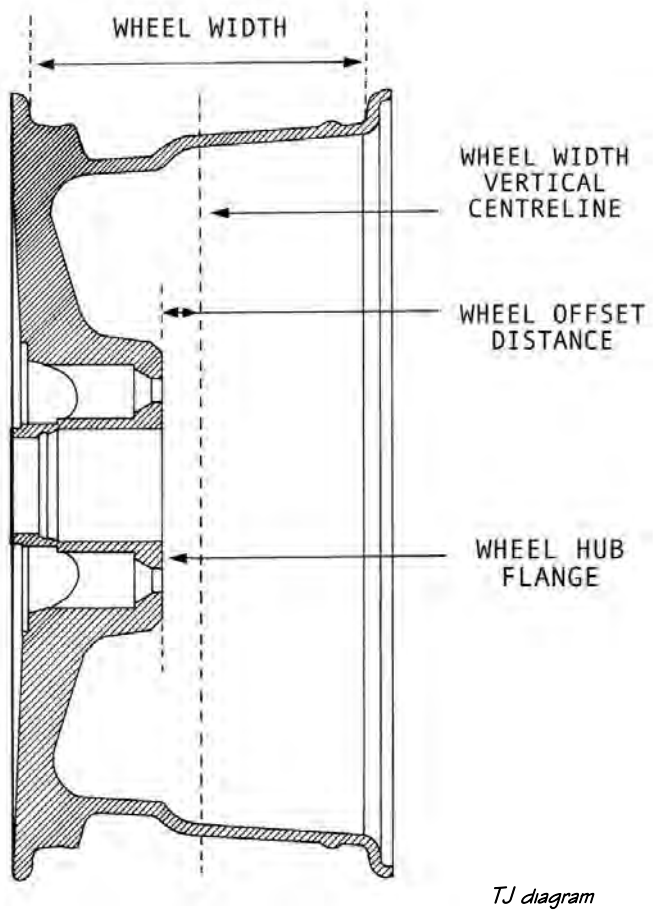


Diagram 12.2 Wheel offsets

12.6.1

A wheel fitted to a Jaguar independent rear suspension assembly should ideally not exceed 10% offset.

Diagram 12.2

The diagram shows negative offset – the hub flange is to the outside of the wheel centerline – positioned toward the outside edge of the wheel. If the hub flange was positioned on the other side of the centre-line – toward the inside edge of the wheel - it would have positive offset.

When a spacer or adaptor is fitted, the reference point from which to measure the offset, shifts from the wheel hub flange to the wheel hub side of the spacer.

'Back-space' is the distance from the hub flange to the back edge of the wheel-rim.

12.7 Dual wheel conversions

12.7.1

A low volume vehicle originally equipped with a rear axle that has a single wheel configuration, may be converted to a dual wheel configuration, provided that the greater loads imposed by the increased wheel offset introduced by the second wheel, are compensated for, by either:

(a) *the fitting of a complete dual-wheel axle assembly sourced from a production vehicle of similar or greater weight; or*

(b) *the fitting of another single wheel axle that was sourced from a vehicle that is substantially heavier than the vehicle to which the axle assembly is now fitted; or*

(c) *the conversion of the original single wheel axle to a semi-floating or fully-floating hub axle assembly.*

Wheel modification and manufacturing requirements:

12.8 All wheel modifications

12.8.1

A wheel fitted to a low volume vehicle may be modified, provided that the modification is carried out by a person who is recognised by a low volume vehicle certifier as:

(a) *being competent and experienced in the type of work being undertaken; and*

(b) *being professionally engaged in the wheel manufacturing or modification industry; and*

(c) *having the necessary equipment to carry out the modifications safely.*

12.8.1

Wheel modification is a very specialised area, and builders should only deal with those 'in the business', who have been in the game for a long time and have a good reputation.

12.9 Wheel pitch circle diameter modifications

12.9.1

A wheel fitted to a low volume vehicle may be modified to provide a change in pitch circle diameter by re-drilling, elongating, or slotting of the wheel centre, provided that:

(a) *the modification incorporates either:*

(i) *centering sleeves and washers to locate and secure the wheel; or*

(ii) *in the case of an aluminium wheel, the drilling and pressing in of a steel insert to accept a tapered wheel nut or bolt;*

and

(b) *the modification is carried out by a person who meets the requirements specified in 12.8.1.*

12.10 Steel wheel widening

12.10.1

A steel wheel fitted to a low volume vehicle may be widened, provided that:

(a) *there is no significant run-out or misalignment; and*

(b) *in the case of a wheel that has the centre fixed to the rim by riveting, the centre is re-fixed to the rim by welding; and*

(c) *the amount by which the wheel is widened is not more than:*

(i) *in the case of a wheel having a diameter of 254 mm (10") or less, 51 mm (2"); or*

(ii) *in the case of a wheel having a diameter of more than 254 mm (10"), 76 mm (3");*

and

(d) *the widening is carried out by a person who meets the requirements specified in 12.8.1; and*

(e) *the welding involved in the widening process is carried out by a person who meets all welding requirements specified in 18.7 of 'Chapter 18 - Attachment Systems'.*

12.10.2

A steel wheel fitted to a low volume vehicle that is widened through the insertion of a steel band must, in addition to 2.10.1, be:

(a) *joined at the section of the wheel that incorporates the smallest diameter; and*

(b) *made from a mild steel material of a thickness of not less than 3 mm (1/8").*

12.11 Bead-lock wheels

12.11.1

A wheel fitted to a low volume vehicle may, in order to prevent inward dislodgement or rotational movement of a tyre on a wheel, be modified to incorporate a bead-lock tyre attachment system, provided that: (see Diagram 12.3)

(a) *the wheel is of steel construction; and*

(b) *the two steel rings are manufactured from a mild steel material of not less than 6 mm (1/4") thickness, either:*

(i) *cut as a continuous ring with no joins; or*

(ii) *formed from a single piece of flat bar and joined by butt-welding;*

and

(c) *the inner ring provides not less than 15 mm (9/16") of bearing surface to support the tyre bead; and*

(d) *the two steel rings are welded fully around the circumference of their respective wheel sections; and*

(e) *the two steel rings incorporate a means of enabling a visual inspection to establish that the two surfaces are correctly positioned; and*

(f) *the wheel retains the 5-degree slope where the tyre bead seats at the base of the wheel rim; and*

(g) *all edges which contact the tyre surface incorporate a radius of not less than 3 mm (1/8"); and*

(h) *the pitching of the fasteners used to attach the two wheel sections are positioned no further apart than 10 degrees; and*

(i) *the torque setting specified by the wheel manufacturer for the tightening of the fasteners attaching the two wheel sections is clearly and permanently stamped on the outer face of each wheel; and*

(j) *the bead-lock conversion work is carried out by a person who meets the requirements specified in 12.8.1; and*

(k) *the welding involved in the bead-lock conversion process is carried out by a person who meets all welding requirements specified in 18.7 of 'Chapter 18 - Attachment Systems'.*

12.11

Bead-lock wheels are primarily used in off-road competition events, in order to allow low tyre pressures for optimum grip, without resulting in tyre rotation on the rim.

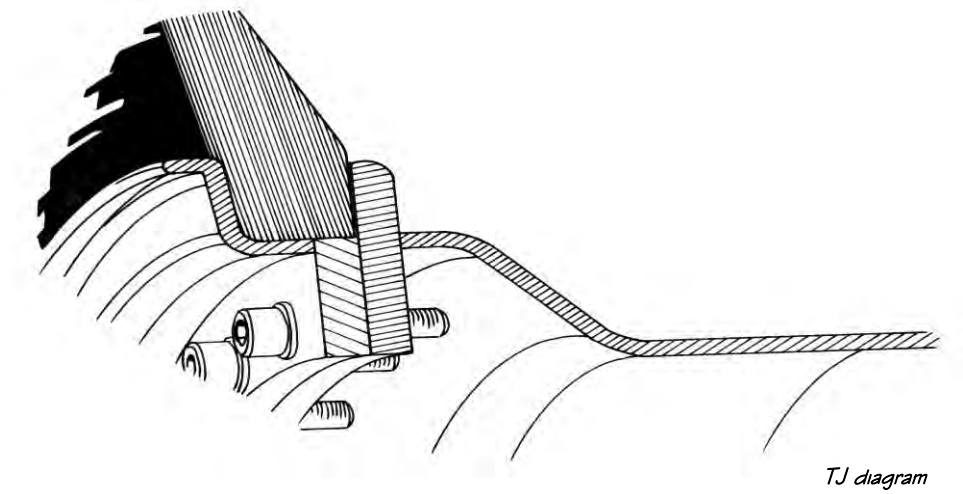


Diagram 12.3 Bead-lock wheels

12.11.2

A fastener used to attach the two wheel sections of a bead-lock wheel together must:

(a) *be of equal or greater size and strength than either:*

(i) *6 mm grade-10.9 metric; or*

(ii) *¼" UNF grade-8 imperial;*

and

(b) *incorporate the correct length of bolt shank for the application; and*

(c) *incorporate a vibration-proof washer or other locking mechanism; and*

(d) *be coated with an anti-corrosive material; and*

(e) *not be electroplated unless:*

(i) *documented evidence is provided to substantiate that a post-plating heat-treatment process has occurred in order to prevent hydrogen entrapment; or*

(ii) *the electroplating process is carried out as part of the manufacturing process by the fastener manufacturer, and documented evidence is provided to substantiate the origin of the fastener.*

12.12 Wheel welding

12.12.1

A wheel fitted to a low volume vehicle may be modified by welding, provided that:

(a) *the modification is a specialised modification to a steel wheel, such as either:*

(i) *wheel widening or centre-changing; or*

(ii) *the conversion of a wheel to a bead-lock tyre attachment system using a design and modification method specified in 12.11;*

and

(b) *except in the case of 12.12.2, any welding involved in the modification process is carried out by a person who, in addition to meeting the requirements specified in 12.8.1, meets all welding requirements specified in 18.7 of 'Chapter 18 - Attachment Systems'.*

12.12.1

Aluminium wheels must not be repaired unless the repair is carried out in accordance with the requirements specified for wheel repair within the *Land Transport Rule: Tyres and Wheels 2001 (Rule 32013)*, in which case it is not a modification.

12.12.2

A steel wheel fitted to a low volume vehicle that has been modified by welding, for which no evidence is available to substantiate that 12.12.1(b) has been complied with, must:

(a) *undergo a thorough visual inspection on both surfaces of each wheel for weld quality, penetration, fatigue cracking, and surface corrosion; and*

(b) *in a case where any doubt exists in relation to the condition of the wheel or quality of the welding, be:*

(i) *non-destructively tested, and comply with, as a minimum, Tables 6.1 or 6.2 of AS/NZS 1554.1:2004 Standard, or an equivalent standard, as applicable to the method of weld examination undertaken, by a person holding not less than a current NDT Level 2 qualification in CBIP, ASNT, AINDT, or other equivalent certification; and*

12.12.2(b)(i)

Note that the tables referred to here are <u>not</u> tables in Chapter 6 of this manual, but are tables within the AS/NZS standard.

(ii) *accompanied by a report supplied by the person who undertakes the non-destructive testing to verify that the requirements of 12.12.2(b)(i) have been met, and that the wheel is considered to be free of defects.*

12.12.3

An aluminium wheel fitted to a low volume vehicle must not be welded for the purpose of modification.

12.13 Hand-built and custom-manufactured wheels

12.13.1

A wheel which is hand-built or custom-manufactured that is fitted to a low volume vehicle, either through a casting or a machining process by someone other than a recognised high-volume aftermarket wheel manufacturer, must be individually pre-approved in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc).

Wheel attachment requirements:

12.14 Wheel and hub assembly compatibility

12.14.1

A wheel fitted to a low volume vehicle must:

(a) *attach to a disc rotor flange or drum or hub face that is large enough in diameter to adequately support the wheel; and*

(b) *have an inside face that is compatible with the hub assembly face to which the wheel attaches; and*

(c) *have no obstructions that could prevent full and even contact between the wheel or the hub or drum face, including set-screws, balance weights, drum shoulder ribs, or the disc caliper; and*

(d) *be securely fastened to the hub assembly.*

12.15 Wheel nut or bolt engagement

12.15.1

A wheel nut or bolt fitted to a low volume vehicle to secure a wheel against a hub assembly must have a mating surface that is compatible to, and machined at the same angle as, the recess in the wheel to which it attaches.

12.15.2

The wheel stud or bolt hole diameter machined into a wheel fitted to a low volume vehicle must be compatible with the diameter of the wheel stud or bolt, to ensure that the wheel nut or bolt properly pulls the wheel against the hub face.

12.15.1

It is critical that a metal to metal contact is ensured, therefore, where a heavy paint build-up such as powder coating is applied to the wheel, the coating in contact with the wheel nut or bolt must be removed.

12.15.2

For example, an XB Falcon wheel (designed for 7/16" studs) must not be fitted to an XY Falcon hub (3/8" studs), as a sloppy fit will occur, and the nuts can bottom out and not properly seat.

12.15.3

A wheel stud or bolt attaching a wheel to a low volume vehicle must engage into or through the corresponding nut or hub assembly by either:

(a) *not less than the diameter of the stud thread; or*

(b) *a specified number of full turns of thread engagement, which must be not less than:*

(i) *in the case of a 12 mm metric stud or bolt with a 1.5 mm coarse thread pitch, 6.5 turns; or*

(ii) *in the case of a 12 mm metric stud or bolt with a 1.25 mm fine thread pitch, 7.5 turns; or*

(iii) *in the case of a 14 mm metric stud or bolt with a 1.5 mm coarse thread pitch, 7.5 turns; or*

(iv) *in the case of a 7/16 inch or ½ inch imperial stud or bolt, 7.5 turns.*

12.15.3

This is a troublesome area. A lot of common and basic off-the-shelf aftermarket wheel fitments don't have sufficient thread engagement left, because of the extra thickness of the aftermarket wheel hub face.

12.16 Wheel studs and bolts

12.16.1

A wheel stud or bolt fitted to a low volume vehicle must:

(a) *be of a type that is purpose-designed for automotive use; and*

(b) *in the case of adaptors being fitted, meet the requirements specified in 12.22; and*

(c) *be in good condition; and*

(d) *in the case of a stud, be attached to the hub assembly in such a way as not to be able to turn with wheel nut tightening.*

12.17 Wheel stud or bolt load capabilities

12.17.1

A low volume vehicle fitted with an engine that is substantially heavier than that which the original hub assembly was designed to support, must have either:

(a) *the original hub assembly replaced by a hub assembly from another vehicle which has an increased number of studs or bolts; or*

12.17.1

'Substantially heavier' in this context generally means where a 6 or 8 cylinder engine has gone into a 4 cylinder vehicle, or where a cast iron diesel has replaced an all-aluminium petrol engine.

(b) *the original wheel studs or bolts replaced by studs or bolts of a diameter equivalent to that of a production vehicle which has a similar engine weight and number of wheel studs or bolts.*

12.17.2

A low volume vehicle fitted with a wheel that has an amount of offset specified in 12.6.1(b) must have either:

(a) *the original wheel studs or bolts replaced by studs or bolts of a diameter not less than one size larger; or*

(b) *the original hub assembly replaced by a hub assembly from another vehicle that either:*

(i) *has an increased number of studs or bolts; or*

(ii) *is of a size, in comparison to the original, that will withstand the additional loadings presented by the increased wheel offset.*

12.18 Centre-lock attachment systems

12.18.1

A splined hub with a centre-lock nut, or other system that uses a centre-lock attachment system, fitted to a low volume vehicle must, if not original equipment, be designed for a vehicle of equivalent or greater weight than the vehicle to which the system is fitted.

Wheel spacing and adaptation requirements:

12.19 Spacer requirements for all wheels

12.19.1

A wheel spacer fitted to a low volume vehicle between the wheel and hub assembly, other than that fitted as original equipment by a high volume vehicle manufacturer, must:

(a) *have a maximum spacing of each wheel away from the hub surface of 20 mm (13/16”); and*

(b) *be set-screwed or attached by another secure mechanical method to either the wheel or hub face; and*

(c) *be manufactured from a solid block of suitable material; and*

(d) *have two machined or die-cast surfaces that are parallel, and contain minimal indentations or irregularities; and*

(e) *be fitted as to ensure the wheel locates snugly over the hub spigot so that the hub carries the weight of the wheel assembly instead of the wheel studs, or where there is a mis-match between the hub spigot and the wheel centre, a close tolerance fit centre bore locator must be provided; and*

(f) *maintain, with the spacer fitted, no less than the minimum required amount of wheel stud or bolt engagement specified in 12.15.3.*

12.20 Additional spacer requirements for cast aluminium wheels

12.20.1

A wheel spacer fitted to a low volume vehicle with cast aluminium wheels, or any other wheels that incorporate a full hub contact surface area, in addition to meeting 12.19.1, may incorporate additional holes within the spacer for multi-fitting purposes, provided that:

(a) *the spacer is designed to fit only one stud configuration; and*

(b) *there is sufficient material provided between the multi-fit holes in order to resist deformation of the spacer.*

12.20.1(a)

'Configuration' means, in this context, that whilst a spacer can be of a multi-fitting design in that it fits varying pitch circle diameters, it must be of a type that will fit either a four-stud wheel or a five-stud wheel, but not both. Spacers that will fit both four-stud and five-stud wheels must not be used in any situations.

12.21 Additional spacer requirements for pressed steel wheels

12.21.1

A wheel spacer fitted to a low volume vehicle with pressed steel wheels, or any other wheels which incorporate a minimal hub contact surface area, in addition to meeting 12.19.1, must not incorporate any holes within the spacer other than those used to:

(a) *where the design of the hub assembly allows, locate the centre hub spigot to the wheel, which must be a close tolerance fit; and*

(b) *attach the spacers to the hub face or wheel rim; and*

(c) *enable the wheel studs being used to attach the wheel to pass through, which must match the stud pattern of the vehicle.*

12.22 Wheel adaptor design and manufacture

12.22.1

A wheel adaptor fitted to a low volume vehicle between the hub and wheel assembly to affect a change in the wheel stud pattern, or to increase wheel offset, must:

(a) *be manufactured by a person who is recognised by a low volume vehicle certifier as:*

(i) *being competent and experienced in the type of work being undertaken; and*

(ii) *having the necessary equipment to carry out the manufacturing process correctly;*

and

(b) *be manufactured from a single block of suitable material; and*

(c) *be of a thickness that,*

(i) *unless the hub assembly donor vehicle is substantially heavier than the vehicle to which the adaptors are fitted, provides a maximum spacing of each wheel away from the hub surface of 30 mm (1 3/16"); and*

(ii) *does not exceed the maximum allowable amount of offset specified in 12.6.1 when the wheel adaptor thickness is included within the wheel offset.*

12.22.1

It is increasingly common to see adaptors being used to achieve an increase in wheel offset, particularly where use of a spacer would necessitate longer studs in order to provide sufficient thread engagement. In such cases, an adaptor can be a better solution.

12.23 Wheel adaptor location

12.23.1

A wheel adaptor fitted to a low volume vehicle between the hub and wheel assembly to affect a change in the wheel stud pattern, must locate, with a close tolerance fit, using the centre spigot or tapered wheel nuts or bolts:

(a) *the adaptor against the hub assembly; and*

(b) *the wheel assembly against the adaptor.*

12.24 Wheel adaptor attachment

12.24.1

A wheel adaptor fitted to a low volume vehicle between the hub and wheel assembly to affect a change in the wheel stud pattern, must attach:

(a) *with no interference between any fastenings attaching the wheel to the adaptor, or adaptor to the hub assembly; and*

(b) *using wheel nuts, studs, or bolts for both the attachment of the adaptor to the hub assembly, and the wheel to the adaptor, that:*

(i) *are a correct match for the type of wheel stud or bolt hole; and*

(ii) *are of a type purpose-designed for automotive use; and*

(iii) *are of a suitable size and pitch circle diameter to carry the loads imposed under normal vehicle operation; and*

(iv) *incorporate not less than the minimum required amount of wheel stud or bolt thread engagement specified in 12.15.3.*

12.24.2

A wheel adaptor must not be fitted to a low volume vehicle in conjunction with a wheel spacer.

Tyre requirements:

12.25 Tyre suitability

12.25.1

A low volume vehicle must be fitted with tyres that:

(a) *are specified by the tyre manufacturer for road use; and*

(b) *are an appropriate selection for the type and width of wheel to which they are fitted; and*

(c) *do not have any visible defects or removal of any sidewall information markings.*

12.25.2

Tyres fitted to a low volume vehicle must be of the same carcass construction on both axles, except in the case of:

(a) *a rear-drive vehicle used for motor-sport purposes that is fitted with radial tyres on the front axle, and tyres of a different carcass construction fitted on the rear axle; or*

(b) *a vehicle of Class MC, LE1, and LE2.*

12.25.2

Where a vehicle specified in 12.25.2 is fitted with tyres of differing front-to-rear carcass construction, the Low Volume Vehicle Certifier must have *"unmatched f-to-r tyre construction"* recorded on the exemption field of the low volume vehicle compliance plate.

Class MC is a four-wheel drive (off-road type) vehicle, LE1 is a trike with one wheel at the front, and a LE2 is a trike with two wheels at the front.

12.26 Tyre compliance

12.26.1

A tyre fitted to a low volume vehicle must be permanently marked on the sidewall with the marking of the approved standard with which the tyre complies, which must be one of the approved standards specified in Table 12.1. (see Table 12.1)

12.26

Alternatively to sidewall marking, a tyre can be accepted if it has documentary evidence to substantiate compliance with the approved standard specified in Table 12.1.

APPROVED STANDARD	MARKING
▪ UN/ECE Regulation No 30	An 'e' within a circle
▪ UN/ECE Regulation No. 54	An 'e' within a circle
▪ 92/23/EEC	An 'e' within a circle
▪ Federal Motor Vehicle Safety Standard No. 109	'DOT' or 'SAE'
▪ Federal Motor Vehicle Safety Standard No. 119	'DOT' or 'SAE'
▪ The Standards of the Japan Automobile Tyre Manufacturers' Association, Inc.	(No compliance marking required on tyre)
▪ Japanese Industrial Standard D 4230, Tyres for Automobiles	'JIS' within a circle
▪ Australian Design Rule 23, Passenger Car Tyres	(No compliance marking required on tyre)
▪ Australian/New Zealand Standard AS/NZS 2230	(No compliance marking required on tyre)
▪ New Zealand Standard 5453	'NZS 5453'

Table 12.1 Tyre compliance table

12.27 Tyre loading and performance

12.27.1

A low volume vehicle must be fitted with tyres capable of meeting the load-carrying potential of the vehicle, in accordance with Table 12.2. (see Table 12.2)

12.26

See 'Useful Information' section for more details.

LOAD INDEX SYMBOL	0	10	20	30	40	50	60	70	80	90	100	110	120
MAX. LOAD RATING (kg)	45	60	80	106	140	190	250	335	450	600	800	1060	1400

Table 12.2 Tyre load symbols and rating

12.27.2

A low volume vehicle must be fitted with tyres capable of meeting the performance potential of the vehicle, in accordance with Table 12.3. (see Table 12.3)

SPEED RATING SYMBOL	L	M	N	P	Q	R	S	T	U	H	V	Z
MAX. VEHICLE SPEED (km/h)	120	130	140	150	160	170	180	190	200	210	240	240+

Table 12.3 Tyre speed symbols and rating

12.27.3

A tyre fitted to the front of a low volume vehicle must have a tread section width of no less than 30% of the tread section width of the rear tyre.

12.28 Tyre positioning

12.28.1

A tyre fitted to a low volume vehicle must be positioned in such a way that it does not rub on any suspension, steering, or braking components, or the chassis, sub-frame, body structure, or outer body panels, during all normal vehicle operation.

12.28.2

A tyre fitted to a low volume vehicle must be contained within the confines of the bodywork, and no part of the tread section may protrude beyond the outer edge of the body, mudguard, or mudguard flare or extension.

12.29 General safety requirements

12.29.1

A tyre must be of good quality and construction, fit for its purpose and maintained in a safe condition.

12.29.2

A tyre must not have worn, damaged or visible cords apparent by external examination.

12.28.2

A vehicle that has been issued with a LVV Fender Exemption Authority Card by the New Zealand Hot Rod Association (Inc) is not required to comply with this – see Exclusion 12.31.1. Note however, that a Fender Exemption cannot be issued for a vehicle with tyres that protrude from beyond the mudguards. This exemption system is only applicable to traditional fenderless vehicles that meet the criteria specified in 'Chapter 13 – Body Modification and Construction'.

12.29

The requirements in 12.29 are taken from the general safety requirements of the Land Transport Rule for Tyres and Wheels.

12.29.3

If fitted, a unidirectional tyre must be fitted to a wheel position corresponding to its direction of rotation.

12.29.4

A tyre on a motor vehicle must have a tread pattern, excluding any tie-bar or tread-depth indicator strip, of not less than 1.5 mm (1/16") in depth across at least three-quarters of the width of the tread and around the entire circumference of the tyre.

Exclusions:

12.30 Original equipment exclusions

12.30.1

A low volume vehicle that is 30 years old or older, or replicates a specific make and model of vehicle that is 30 years old or older, is not required to comply with 12.26, provided that the vehicle is fitted with a size and type of tyre that was supplied as standard or optional equipment by:

(a) *the original vehicle manufacturer; or*

(b) *in the case of a scratch-built low volume vehicle, the original manufacturer of the vehicle being replicated.*

12.31 LVV Authority Card (mudguard) exclusions

12.31.1

A low volume vehicle, for which a valid Low Volume Vehicle Authority Card is issued by an LVVTA-approved organization, that specifies 'mudguard exemption', is not required to comply with 12.28.2.

Useful information:

Tyre compliance

Whilst most overseas standards jurisdictions (such as those found in Table 12.1) require their marking to be permanently stamped onto the sidewall of the tyre, some, such as one of the Japanese, and the two Australian jurisdictions, don't require this. This makes it hard for us to look at a tyre and know whether or not it complies, especially if we're looking at a tyre that was designed for sale into the Australian market. Generally speaking, if a tyre has 'Made in Japan' on it, and it is either a Bridgestone, Yokohama, Ohtsu, Nitto, Sumitomo, Michelin, Toyo, Dunlop, BF Goodrich, or Riken tyre, it is deemed to comply with an approved standard, despite the fact that no approved standards marking appears on the tyre.

Directional tyres

There are two different types of directional markings on tyres. These are 'rotation', and 'drive'. Race tyres are marked with 'drive' direction, as distinct from performance unidirectional road tyres that are marked with 'rotation' direction.

The front tyres on a rear drive race car are subjected only to braking 'drive' forces, and the rear wheels mainly acceleration 'drive' forces, hence the 'drive' arrows are fitted in opposite directions in a racing tyre situation, whereas unidirectional road tyres on a road car would always face the same direction.

Pro-street rear tyre selection

'Bias-construction' and 'cross-ply' construction tyres are effectively the same. Essentially, this is technology from the 1930s, when vehicles were so slow that such poor tyre technology didn't matter. Nowadays, even most trucks don't have cross-plys any more.

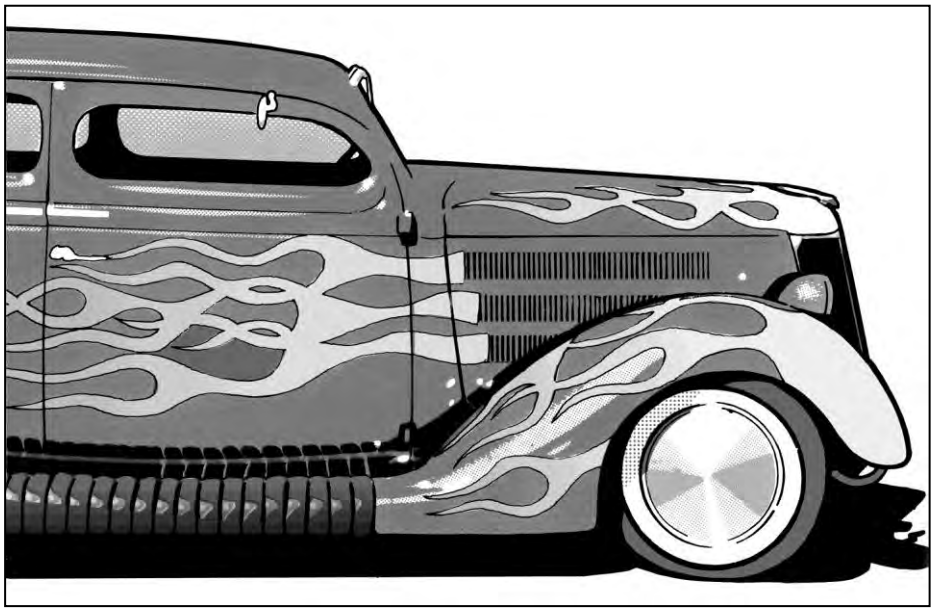
A bias-ply or cross-ply tyre has its place on nostalgia-style hot rods and period special sports cars, but they shouldn't ever be used on a modern performance-oriented hobby car. The one type of modern high-performance vehicle that does need a bias or cross-ply tyre, simply because there isn't an alternative, is the 'pro-street' style of car, where 12" or more of rubber is needed on each side at the rear. Most of the bias-ply tyres that have traditionally been used on pro-streeters, have been a hard-compound tyre, only designed for long life. The traction characteristic of these tyres on wet roads is atrocious, especially so if the vehicle is light-weight as well. If you need a big tyre for the back of your pro-streeter, and because of size availability you have to go with a bias-ply tyre, make sure you use a bias-ply tyre designed for drag racing. These tyres are (comparatively) of a very soft compound, which allows the tyres to generate sufficient heat to provide better grip, on both wet roads and dry. They'll wear out in half the time of the others, but that's a small price to pay for the safety they provide over the other type.



TJ illustration

Chapter 13:

BODY MODIFICATION & CONSTRUCTION



TJ illustration

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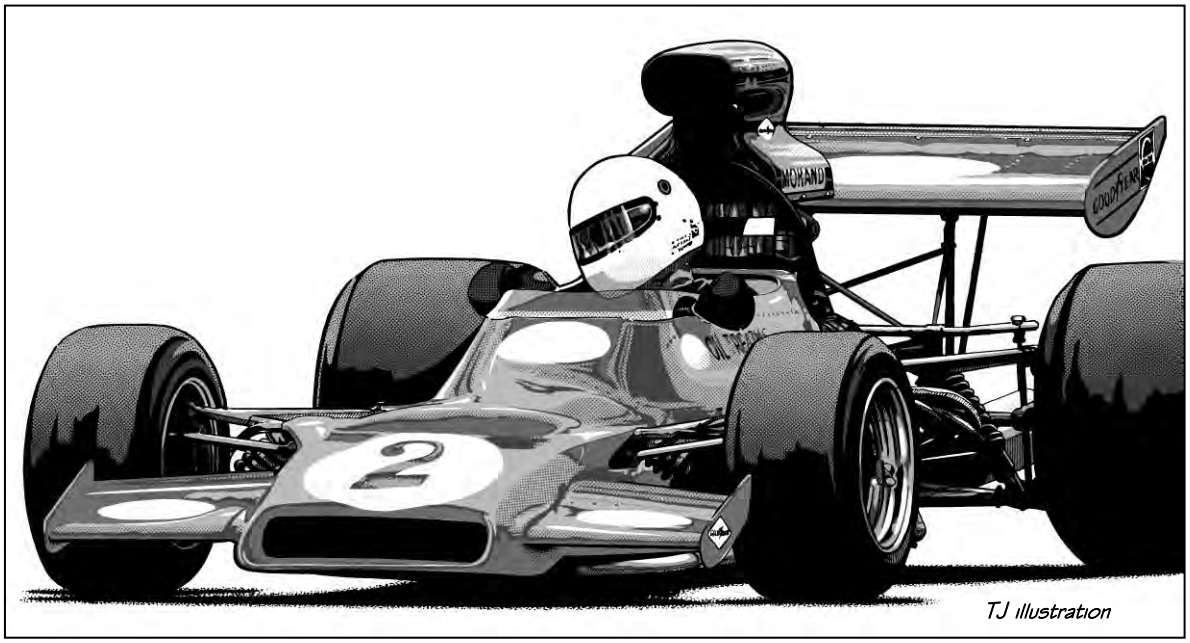
13.28 Design criteria exclusions Page 13-16

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Key: (for full key details, refer to 'Chapter 2 – About this Manual')

Normal type: Provisions of the NZ Car Construction Manual for all vehicles
Normal type in shaded box: Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates
Italic type: *Extracts from any relevant LVVTA Low Volume Vehicle Standards*
Script type: Helpful hints, tips, explanations, clarifications, and interpretations
Shaded text & dotted vertical stroke in margin: Latest amendments since previous version



CHAPTER 13: BODY MODIFICATION & CONSTRUCTION

Introduction:

This body modification and construction chapter is an interim chapter, containing for the most part the regulatory requirements relating to components and systems covered by Land Transport rules, that we have to comply with, via the low volume vehicle alternative standards. These systems and components include frontal impact, door retention systems, and external projections. After the publication of this Car Construction Manual, over time this chapter will be added to substantially, to cover issues such as roof-chops, roof removals, recessed firewalls, tubbed rear sections, tilt-fronts, and other common body-related modifications.

Note that where original or authentic reproduction parts are fitted to a production vehicle, the requirements in this chapter do not apply.

Body structure and panel requirements:

13.1 General body requirements

13.1.1

A low volume vehicle must not have any structural part of its body weakened by rust, corrosion, cracking, or other damage.

13.1.2

A low volume vehicle which has a body built from composite materials must meet the requirements specified for composite construction in 5.15 to 5.18 in 'Chapter 5 - Chassis Modification and Construction'.

13.2 Floor and front bulkhead requirements

13.2.1

A low volume vehicle must incorporate:

(a) a floor-pan that is strong enough to support, during all normal and impact loads:

(i) the weight of any occupants; and

(ii) any components attached to it;

and

(b) an engine bulkhead that forms a permanent firewall capable of preventing fire, smoke, liquids, and vapour, from entering the passenger compartment from the engine bay.

13.2.1(b)

Fibre-glass is an acceptable material for a bulkhead to be made from.

13.3 Body attachment requirements

13.3.1

A low volume vehicle must incorporate:

(a) body mounts that meet the attachment requirements specified in 5.23 of 'Chapter 5 – Chassis Modification and Construction'; and

(b) in the case of a low volume vehicle with a fibre-glass body and a wooden floor, steel reinforcing plates for the body mounting points fibre-glassed into the floor, or welded directly to the steel body framing.

13.4 Roll-bar and framing requirements

13.4.1

A low volume vehicle that does not have a fixed roof must incorporate roll-bar mounting points within the chassis, suitable for a minimum of 38 mm x 2.5 mm (1 1/2" x 1/8") tubing.

13.4.1

An open vehicle does not have to have a roll-bar, but it must have provision for one, so that a roll-bar can be easily added later on.

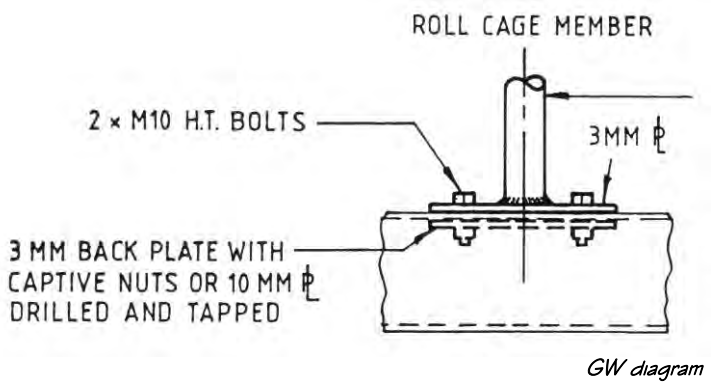
13.4.2

A roll-bar fitted to a low volume vehicle must be attached to the vehicle structure by either:

(a) using one of the methods specified in Diagram 13.1 or 13.2 (as applicable); or

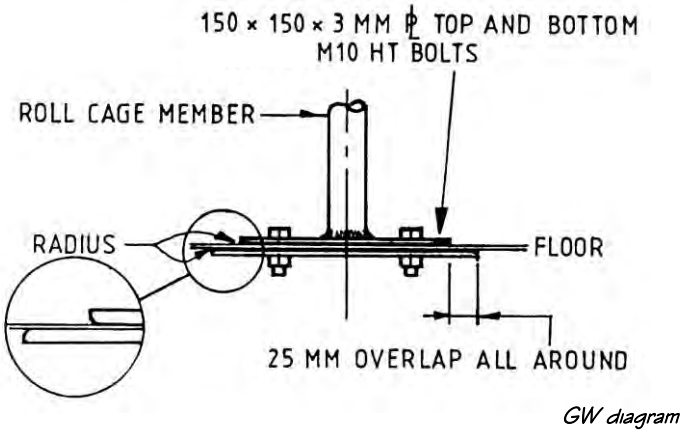
(b) welded to the chassis or body structure in accordance with the requirements specified in 18.7 and 18.8 of 'Chapter 18 - Attachment Systems'.

While this specification is legal for road use, it should be noted that NZDRA require a minimum wall thickness of 3 mm (1/8") for main bars in a roll-cage.



GW diagram

Diagram 13.1 Roll-bar attachment for body/chassis vehicles



GW diagram

Diagram 13.2 Roll-bar attachment for unitary constructed vehicles

13.5 Body panel requirements

13.5.1

An engine hood, if fitted to a low volume vehicle must be secured into its closed position with either:

(a) a latching system that incorporates a primary and a secondary latching mechanism; or

(b) two separate latching devices, such as engine hood pins, clips, or straps.

13.5.2

A low volume vehicle, other than one specified in 13.5.3, must be fitted with a mudguard that covers no less than the full width of the tread, and one-third of the circumference, of each tyre, positioned in such a way as to minimise the displacement of spray and debris to the rear of the vehicle. (see Diagram 13.3)

13.5.1

Two or more engine hood pins, or two or more suitable over-hood straps, such as those typically found on pre-war vehicles, are acceptable systems.

The TAC reminds builders and modifiers about the ease with which an engine hood secured with hood pins can be mistakenly left unsecured – with hood pins not inserted, the engine hood still appears at a glance to be 'in position'. Be careful out there!

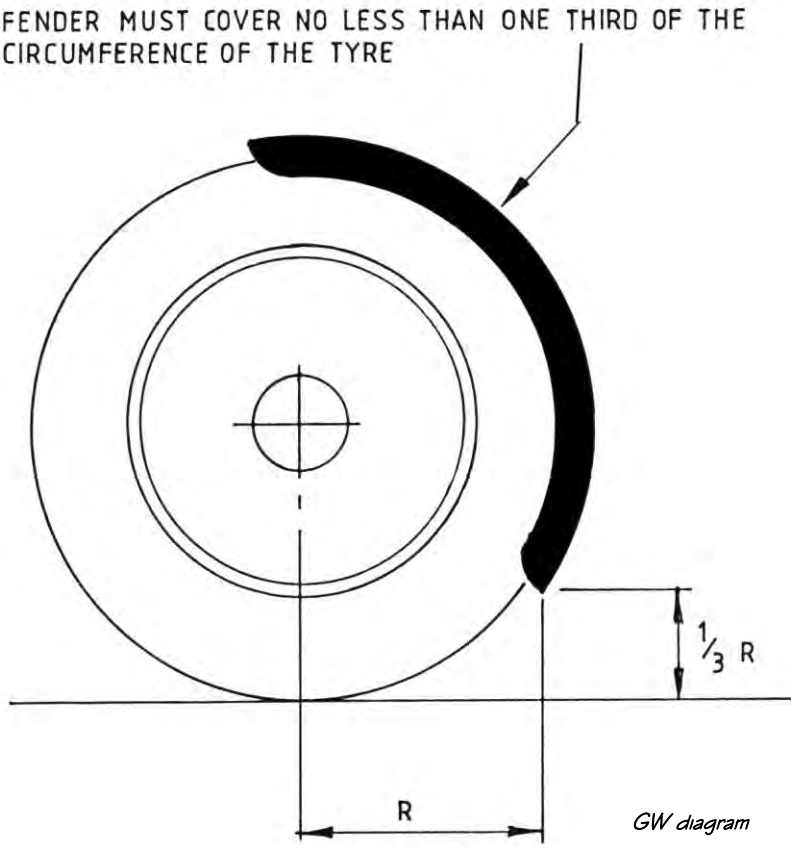


Diagram 13.3 Mudguard positioning

13.5.3

A low volume vehicle that is issued with a valid and current LVV Authority Card applicable to a fenderless vehicle, issued by the New Zealand Hot Rod Association (Inc) as specified in 'Chapter 3 – LVV Authority Cards', is not required to be fitted with mudguards.

13.5.3

The Authority Card only provides for vehicles that have no fenders fitted – it does not apply to vehicles with fenders of insufficient width.

See the 'Useful Information' section at the back of this chapter for more information on LVV Authority cards.

Frontal impact requirements:

13.6 Modified production low volume vehicles

13.6.1

A production low volume vehicle must not feature any modifications to any crumple zones or other energy-absorbing measure incorporated by the vehicle manufacturer within the frontal impact protection system.

A modified production low volume vehicle modified before 2002 is not required to comply with 13.6.1.

13.6

For more information on the frontal impact subject, see the 'Useful Information' section at the back of 'Chapter 5 – Chassis Modification and Construction'.

13.6.2

A modification to the body of a production low volume vehicle must be carried out in such a way as to:

(a) *minimise any longitudinal stiffening of the vehicle structure forward of the occupant cell; and*

(b) *minimise the risk of deformation of the occupant cell during a frontal impact; and*

(c) *minimise the likelihood of penetration of the engine or transmission into the occupant cell during a frontal impact.*

A modified production low volume vehicle modified before 2002 is not required to comply with 13.6.2.

13.6.3

This is a general safety requirement from Land Transport Rule 32006/1, which is reproduced here in the interest of convenience. This is the rule that prevents bull-bars being fitted to cars, occupant protection airbags being removed, and many other modifications that used to happen regularly some years ago.

13.6.3

The performance of a low volume vehicle, in relation to protecting occupants in a frontal impact collision, must not be reduced below a safe tolerance of its state when manufactured or modified, by any factors, including corrosion, structural damage, material degradation, inadequate repair, the fitting of additional equipment, or the removal of equipment.

13.7 Scratch-built low volume vehicles

13.7

For more information on the frontal impact subject, see the 'Useful Information' section at the back of 'Chapter 5 – Chassis Modification and Construction'.

13.7.1

The body of a scratch-built low volume vehicle must be constructed in such a way as to:

(a) *minimise the likelihood of penetration of the engine, transmission, suspension, body structure or parts into the passenger compartment as a result of a frontal collision; and*

(b) *maximise the likelihood that the section of the vehicle forward of the passenger compartment will progressively absorb impact energy without significant deformation of the occupant cell, by featuring design characteristics forward of the passenger compartment consistent with those expected of contemporary high volume production vehicles.*

13.7.1

Where possible, materials should be used in the firewall and gearbox tunnel area to try and assist deflection of the engine and gearbox downwards, rather than straight backward into the vehicle interior, in an impact.

A scratch-built low volume vehicle constructed before 2002 is not required to comply with 13.7.1.

Door opening requirements:

13.8 General door opening requirements

13.8.1

A door fitted to a low volume vehicle must:

(a) *open and close easily; and*

(b) *remain secure in a closed position during operation of the motor vehicle; and*

(c) *be operable at all times by any occupant seated by the door, from inside the vehicle.*

13.9 Door opening from inside the vehicle

13.9.1

A door fitted to a low volume vehicle must be fitted with a mechanically operated interior handle or other mechanically-operated opening device, which can be easily accessed and operated at all times from inside the vehicle.

13.10 Door opening from outside the vehicle

13.10.1

A door fitted to a low volume vehicle is not required to be able to be opened from outside the vehicle by a mechanical means.

13.10.2

An exterior door handle or other opening device may be positioned in a hidden location on a low volume vehicle, provided that either:

(a) *the location is such that the handle or opening device is shielded or protected to prevent unintentional activation by contact from road debris; or*

(b) *the handle or opening device is positioned in such a way so as not to be able to be unintentionally activated.*

13.10.3

A door fitted to a low volume vehicle may be opened from outside the vehicle by:

(a) *a fixed electrically-operated unlatching device; or*

(b) *a remote electrically-operated unlatching device, provided that a fail-safe inter-lock system is incorporated to prevent unlatching of the doors unless either:*

(i) *the ignition system is switched off; or*

(ii) *in the case of a vehicle equipped with an automatic transmission, a gearbox inhibitor switch operating only in neutral and park is engaged.*

Door retention system requirements:

13.11 General door retention system requirements

13.11.1

A door retention system and its mountings fitted to a low volume vehicle must be safe, and structurally sound.

13.11.2

A burst-proof door retention system that meets 13.11 to 13.20 must be fitted to any:

(a) scratch-built low volume vehicle; or

(b) modified production low volume vehicle which has had its front-hinged doors converted to a rear-hinged mounting system.

A low volume vehicle built or modified before January 1992 is not required to comply with 13.11.2.

13.12 Door latch and striker assembly design

13.12.1

A door latch and striker plate assembly fitted to a low volume vehicle must:

(a) be designed for automotive use; and

(b) be of a burst-proof design; and

(c) incorporate two latching positions, comprising:

(i) a primary latching position; and

(ii) a secondary latching position.

A low volume vehicle built or modified before January 1992 is not required to comply with 13.12.1.

13.11

The intention of having door retention system requirements is to maximise the chances of doors remaining closed in an impact, in order to prevent occupants from being thrown from the vehicle.

13.11.2

A vehicle built or modified before January 1992 is not required to meet any of the requirements in this Chapter for door latching or hingeing, other than for 13.11.1.

13.11.2(b)

This means that the door on a production vehicle - say, a steel Model-A Coupe – never has to be retro-fitted with burst-proof door latches, unless the original front-hinged doors have been 'suicided' (hinged from the rear), in which case a burst-proof door retention system is required to be installed.

13.12.1

A 'burst-proof' latch will, when engaged, completely encircle the striker pin, so that the latch and the pin cannot become disengaged, whether pulled in the fore-aft, up-down, or inward-outward directions.

13.13 Door latch and striker assemblies from production vehicles

13.13.1

A door latch and striker plate assembly sourced from a production motor vehicle may be fitted to a low volume vehicle, provided that the vehicle to which the assembly was originally fitted was manufactured in either:

(a) *the United States of America on or after 1 January 1968; or*

(b) *Europe or the United Kingdom on or after 1 January 1970; or*

(c) *Japan on or after 1 January 1983; or*

(d) *Australia on or after 1 January 1988.*

A low volume vehicle built or modified before January 1992 is not required to comply with 13.13.1.

13.14 Aftermarket door latch and striker assemblies

13.14.1

A door latch and striker plate assembly sourced from an aftermarket manufacturer may be fitted to a low volume vehicle, provided that:

(a) it meets the door latch and striker assembly design requirements specified in 13.12; and

(b) the latch tongue is not electroplated; and

(c) the latch tongue, striker pin, and other principle components within the assembly are comparable to the same components found in a door latch and striker plate assembly specified in 13.13, in relation to:

(i) component size; and

(ii) component design; and

(iii) material specification.

13.14.1(b)

Tongues on aftermarket latches must remain in an un-plated black tempered state - any aftermarket latches with electroplated tongues that have been tested by LVVTA, have failed.

A low volume vehicle built or modified before January 1992 is not required to comply with 13.14.1.

13.15 Door latch and striker assemblies from other sources

13.15.1

In the case of an alternative door latch and striker plate assembly fitted to a low volume vehicle that is not specified in 13.13 or 13.14, practical calculation or testing must be applied to prove the system's ability to withstand a force that may deform the components but not result in ultimate failure or its inability to function as intended, of:

(a) *in the primary latching position, applied individually:*

(i) *11 kN applied in the longitudinal direction; and*

(ii) *8.9 kN applied in the lateral direction;*

and

(b) *in the secondary latching position, applied individually, 4.4 kN applied in both the longitudinal and lateral directions.*

A low volume vehicle built or modified before January 1992 is not required to comply with 13.15.1.

13.16 Door hinge assembly design

13.16.1

A door hinge assembly fitted to a low volume vehicle must incorporate not less than two hinge assemblies for each door, unless a single hinge is designed with sufficient strength so as to be no less strong than a conventional pair of hinges.

A low volume vehicle built or modified before January 1992 is not required to comply with 13.16.1.

13.17 Door hinge assemblies from production vehicles

13.17.1

A door hinge assembly sourced from a production motor vehicle may be fitted to a low volume vehicle, provided that:

(a) *the door to which the hinge assembly is fitted is of similar or lower mass than that of the door to which the hinge assembly was originally fitted; and*

(b) *the hinge assembly is positioned such that the loads to which it is subjected are no greater than in the original application of the hinge assembly; and*

(c) *the vehicle to which the assembly was originally fitted was manufactured in either:*

(i) *the United States of America on or after 1 January 1968; or*

(ii) *Europe or the United Kingdom on or after 1 January 1970; or*

(iii) *Japan on or after 1 January 1983; or*

(iv) *Australia on or after 1 January 1988.*

A low volume vehicle built or modified before January 1992 is not required to comply with 13.17.1.

13.18 Aftermarket or custom door hinge assemblies

13.18.1

A hinge assembly that is custom-built or sourced from an aftermarket manufacturer may be fitted to a low volume vehicle, provided that the assembly comprises:

(a) in the case of a hinge pin used in a single-shear situation, either:

(i) a dowel-pin or cap-screw of equal or greater size and strength than 4 mm grade-10.9 metric (5/32" grade-8 imperial); or

(ii) a high-tensile bolt of equal or greater size and strength than 6 mm grade-8.8 metric (1/4" grade-5 imperial);

or

(b) in the case of a hinge pin used in a double-shear situation, either:

(i) a dowel-pin or cap-screw of equal or greater size and strength than 3 mm grade-10.9 metric (1/8" grade-8 imperial); or

(ii) a high-tensile bolt of equal or greater size and strength than 5 mm grade-8.8 metric (3/16" grade-5 imperial);

or

(c) in the case of mounting plates bolted through panel steel, four high-tensile bolts of equal or greater size and strength than 4 mm grade-10.9 metric (5/32" grade-8 imperial), attaching a 40 mm x 40 mm x 2 mm (1 ¾" x 1 ¾" x 5/64") plate that has:

13.17.1(c)

A door hinge assembly can be used from a production vehicle other than those specified in 13.17.1(c) provided that the LVV Certifier is satisfied, on the basis of a thorough visual inspection, that the design and strength of the hinge assembly (the pin especially) being used is comparable to a hinge assembly from a vehicle specified in 13.17.1(c) or 13.18.1.

Where the LVV Certifier is in any doubt about the above, calculation or testing, as specified in 13.19.1, must be applied.

(i) a radius of 5 mm (13/64″) applied to all corners; and

(ii) chamfering applied to all internal edges; and

(iii) been shaped to conform with the panel section; and

(iv) a centrally-positioned locating pin;

or

(d) in the case of mounting plates welded to chassis or body frame sections, a full penetration weld the full length of two sides of each 40 mm x 40 mm x 2 mm (1 ¾″ x 1 ¾″ x 5/64″) plate.

A low volume vehicle built or modified before January 1992 is not required to comply with 13.18.1.

13.19 Door hinge assemblies from other sources

13.19.1

In the case of an alternative door hinge assembly fitted to a low volume vehicle that is not specified in 13.17 or 13.18, practical calculation or testing must be applied to prove the hinge assembly's ability to withstand a force that may deform the components but not result in ultimate failure or its inability to function as intended, of 11 kN, applied individually, in both the longitudinal and lateral directions.

A low volume vehicle built or modified before January 1992 is not required to comply with 13.19.1.

13.20 Body and door structure strength requirements

13.20.1

The door structure to which a latch and striker plate assembly, and hinge assembly is fitted must be of such a design, or be suitably reinforced, to ensure that the door is sufficiently strong to withstand the same loads required of the latch, striker, and hinge assemblies specified in 13.15 and 13.19.

A low volume vehicle built or modified before January 1992 is not required to comply with 13.20.1.

13.20.2

The body structure to which each end of a door is attached by the latch, striker, and hinge assembly must be of such a design, or be suitably reinforced, to ensure that the body pillars and surrounding structure are sufficiently strong to withstand the same loads required of the latch, striker, and hinge assemblies specified in 13.15 and 13.19.

A low volume vehicle built or modified before January 1992 is not required to comply with 13.20.1.

External projection requirements:

13.21 General external projection requirements

13.21.1

All low volume vehicles must comply with the following general safety requirements:

(a) *ornamental objects and fittings must not protrude from the motor vehicle if they could injure any person; and*

(b) *protruding objects and fittings which have a functional purpose must, if installed and operated on vehicles that are used on any public road, be such that their risk of causing injury to any person is minimised; and*

(c) *protruding objects and fittings must not adversely affect driver vision or driver control; and*

(d) *components of the vehicles, including damaged or corroded body panels must be such that their risk of hooking any vehicle, or hooking or grazing any person is minimised.*

13.22 Non-functional external projections

13.22.1

Protruding external objects or fittings that do not have a functional purpose may not be fitted to low volume vehicles if they are likely to increase the risk of injury to any person, including the following three requirements for non-functional items:

(a) *ornamental hood emblems must be designed and attached in such a way that they will fold back or break off in the event of contact, without leaving any sharp edges; and*

(b) *protruding bumper bars must have a radius on all edges and corners of no less than 3 mm (1/8"); and*

(c) *wheel hubs or centres which extend beyond the external line of the body of the vehicle must have a radius on any exposed edges of no less that 3 mm (1/8").*

13.21

The intention behind having external projection requirements is to try and minimise the additional injuries that could be sustained by a pedestrian, in the event of coming into contact with the vehicle, and also to reduce the chances of a pedestrian being entrapped or hooked by something protruding from a vehicle.

13.21.1

The requirements specified in 13.21.1 are the applicable general safety requirements from the Land Transport Rule 32008, reproduced here in the interest of convenience.

13.23 Functional external projections

13.23.1

Protruding external objects or fittings that have a functional purpose, not including those items on the underside of the vehicle, may not be fitted to low volume vehicles unless their design, construction, condition, and manner in which they are affixed to the vehicle is such that the risk of causing injury to any person is minimised, including the following five requirements for functional items:

(a) *free-standing lamps must protrude no further from the vehicle body than is necessary for their effective operation; and*

(b) *items such as door handles, engine hood latches, and fuel filler caps must protrude no further from the vehicle body than is necessary for their effective operation; and*

(c) *engine hood scoops or engine components protruding beyond the original external line of the engine hood which are contactable by a 165 mm (6 ¾") head-sphere, must have a radius on all such exposed contactable edges of no less than 3 mm (1/8"); and*

(d) *exposed moving mechanical objects including drive pulleys and belts must be protected by a guard or cover, and the guard or cover must have a radius on all edges and corners of no less than 3 mm (1/8"); and*

(e) *external exhaust systems which extend beyond the outer longitudinal extremity of the vehicle or the outer sidewall of the tyres, must:*

(i) *have a radius of no less than 3 mm (1/8") on any sections facing toward the front of the vehicle; and*

(ii) *have any sections of exposed exhaust contactable from the front of the vehicle or adjacent to points of occupant entry and exit adequately heat-shielded.*

13.24 Other external projection requirements

13.24.1

All contactable exterior sheet-metal edges must fold back by not less than 90 degrees.

13.24.2

Any contactable exterior cosmetic or aerodynamic attachments must not extend laterally beyond the widest part of the vehicle body.

Other requirements:

13.25 Registration plate requirements

13.25.1

A low volume vehicle must be fitted with two registration plates of a type specified by the Ministry of Transport:

(a) one of which is fitted at the front of the vehicle, and one of which is fitted at the rear of the vehicle; and

(b) each of which is attached in an upright position, and displayed in such a way that each letter and figure is easily visible.

13.25.1

Note that this is a requirement under the Transport (Vehicle & Driver Registration & Licensing) Notice 1995, and a vehicle with a plate obscured by grille bars or similar, could be considered to be in breach of this requirement. Home-made plates, including decals, are not allowed.

Plates may be offset to one side of the vehicle providing they are still clearly visible from the front or the rear.

Exclusions:

13.26 General safety requirement exclusions

13.26.1

A low volume vehicle that is not a passenger service vehicle, is not required to comply with 13.8.1(c) and may incorporate on a door to the rear of the driver's seat a safety device that can be temporarily engaged to prevent the door from being opened from inside the vehicle, provided that:

(a) *the device is designed as a 'kiddie-lock'; and*

(b) *there is some means for a rear seat occupant to exit the vehicle in the event of an emergency.*

13.27 Non-structural door exclusions

13.27.1

A modified production low volume vehicle is not required to comply with 13.11 to 13.20 if the vehicle was designed by the manufacturer to operate safely with readily removable lightweight flexible doors functioning as weather protection.

13.28 Design criteria exclusions

13.28.1

A scratch-built low volume vehicle that does not have a permanent roof structure is not required to comply with 13.11 to 13.20 if the vehicle:

(a) *can be operated safely without doors fitted; and*

(b) *is fitted with a web-clamp retractor lap-and-diagonal seatbelt, or another type of seatbelt that exceeds the performance requirements of a web-clamp retractor lap-and-diagonal seatbelt, in the driver and outboard occupant seating positions; and*

(c) *has high-sided sills (between the occupant and outer side of the vehicle) which extend to a point no lower than the H-point, determined by either:*

(i) *an LVVTA body frame; or*

(ii) *measured from an LVVTA H-point template, as shown in Diagram 13.4.*

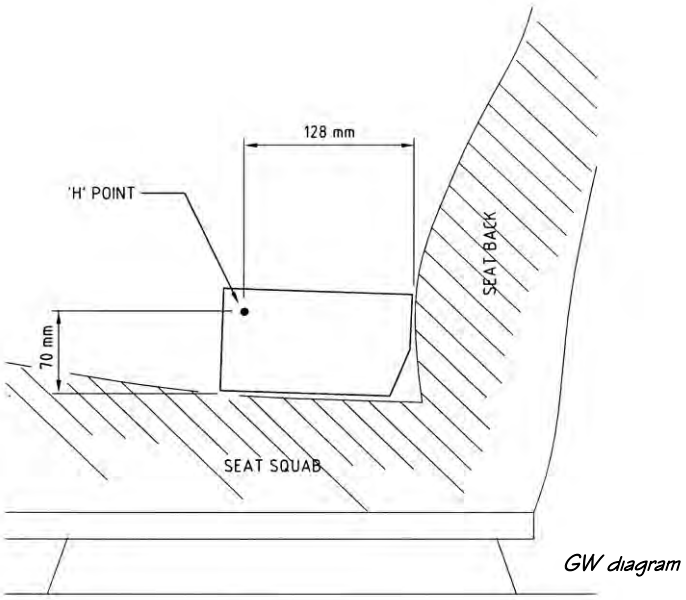


Diagram 13.4 LVVTA H-point template

13.29 Original equipment external projection exclusions

13.29.1

An object or fitting fitted to a modified production low volume vehicle is not required to meet 13.21 to 13.23 provided that the object or fitting is either:

(a) a standard or optional item supplied by the vehicle manufacturer, or an item which is an authentic reproduction of such equipment; or

(b) an item which was available as after-market equipment at the time the vehicle was manufactured.

Useful Information:

LVV Authority cards

A low volume vehicle authority card is only available for a vehicle that is modified for a particular purpose, in order to meet the specific needs of the person nominated on the authority card. LVV Authority Cards can be issued only by the New Zealand Hot Rod Association, and by MotorSport New Zealand. New Zealand Hot Rod Association's Authority Card covers fenderless vehicles, and vehicles that are required by NZHRA's and the New Zealand Drag Racing Association's safety requirements to have a roll-cage. MotorSport New Zealand can issue LVV Authority Cards for various types of equipment that are applicable to their competition vehicles, such as roll-cages, navigational equipment, and hydraulic park brakes. See 'Chapter 3 – LVV Authority Card Process' for all of the details on the NZHRA LVV Authority Card system.

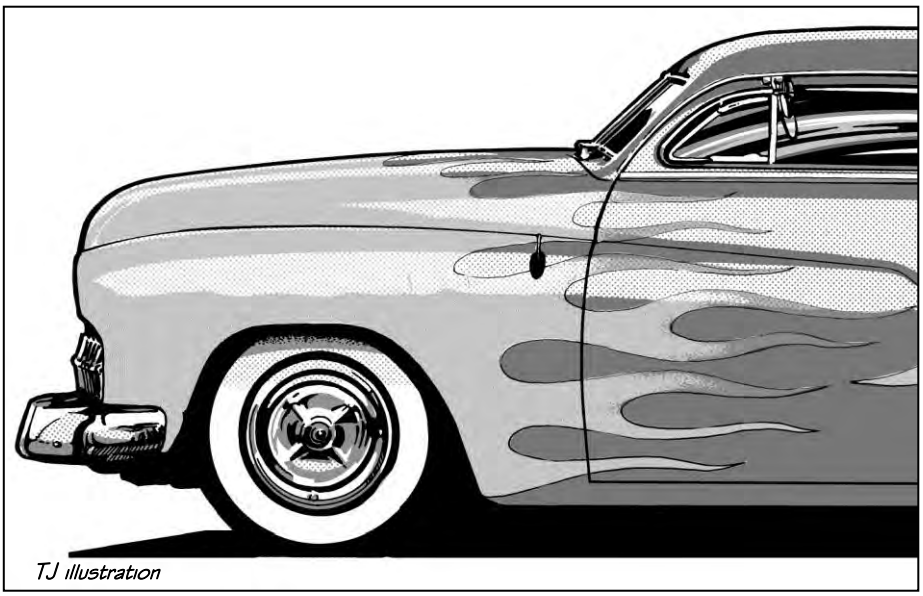
Note that the operator of a vehicle for which an LVVTA-approved authority card is issued, must, when requested by an enforcement officer or LVV certifier, produce the authority card for that vehicle.



TJ illustration

Chapter 14:

SEATS, SEATBELTS, & ANCHORAGES



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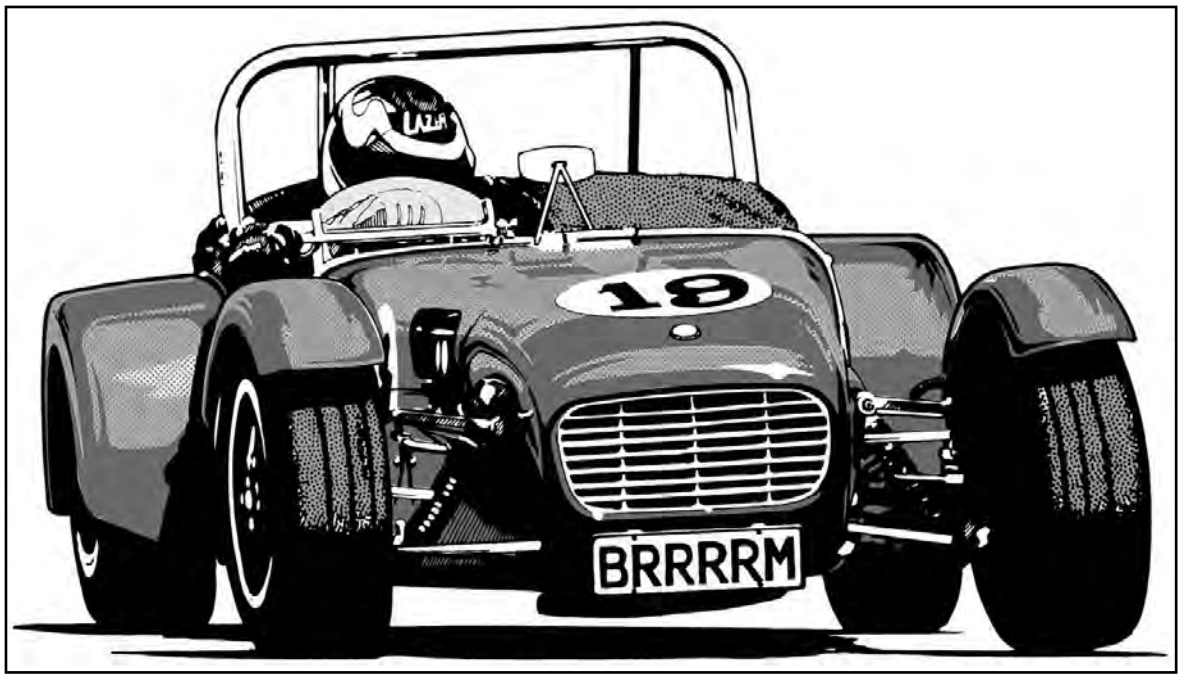
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Key: (for full key details, refer to 'Chapter 2 – About this Manual')

Normal type: Provisions of the NZ Car Construction Manual for all vehicles
Normal type in shaded box: Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates
Italic type: *Extracts from any relevant LVVTA Low Volume Vehicle Standards*
Script type: Helpful hints, tips, explanations, clarifications, and interpretations
Shaded text & dotted vertical stroke in margin: Latest amendments since previous version



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CHAPTER 14: SEATS, SEATBELTS, & ANCHORAGES

Introduction:

The most important safety feature any hobby vehicle can be equipped with is the combination of seatbelts that are correctly positioned and are securely attached to the vehicle structure, together with seats that will remain in position and securely attached to the vehicle structure, in the event of an impact. There are some safety features that will always be compromised to some extent in a one-off hobby vehicle, but there's no good reason or excuse anymore not to have Mum and the kids, and yourself for that matter, properly restrained should the unthinkable happen. Because of the massive loads applied to seatbelt anchorages by your bodyweight, multiplied many times over by the gravitational forces generated in a survivable impact, serious consideration and effort needs to go into sorting out just how the seatbelt anchorages are going to be attached to the vehicle. The same applies to the seats; - if they're not correctly designed and attached, and a failure occurs during an impact, the seatbelts can't do their job properly.

Note that where a production vehicle is fitted with its original unmodified seats, seatbelts, and anchorage systems, the requirements in this chapter do not apply.

General seat requirements:

14.1 Positioning requirements for all seats

14.1.1

A seat fitted to a low volume vehicle for the use of the driver is not required to be provided with adjustment in the longitudinal direction, however, it must in all cases be positioned in such a way as to enable the vehicle to be safely operated by a person within the average range of height and stature.

14.1.2

A seat that is adjustable in the longitudinal plane, that is fitted to a low volume vehicle, must be limited in its range of adjustment so as not to be able, at any point within its range of adjustment, to cause any seatbelt anchorage to be outside of its permitted area, as specified in 14.36 to 14.40.

14.2 Condition and operation requirements for all seats

14.2.1

A seat fitted to a low volume vehicle must be designed, constructed, and positioned so as to provide:

(a) in the case of the driver, a suitable seating position and height from which to comfortably and safely operate the vehicle; and

(b) a seat-back that is capable of supporting the occupant in the event of a rearward collision, or rebound from a frontal collision.

14.2.2

A seat fitted to a low volume vehicle must not be corroded, cracked, or damaged to such an extent that weakening of the frame could occur as a result.

14.2.3

A seat fitted to a low volume vehicle must:

(a) *except for a scratch-built low volume vehicle, be provided with fixed cushioning over the seat back and seat base; and*

(b) *incorporate sufficient padding over all hard or sharp contactable areas to minimise likelihood of injury to occupants in the event of an impact.*

14.3 Seating position dimensions

14.3.1

A multiple seat fitted to a low volume vehicle must contain, in the case of an adult's seat, no more seating positions than the total whole number of times 410 mm (16 ¾") can be divided into the total width of the seat.

14.3.1

This means, for example, that you couldn't have 3 seating positions on a bench seat that has a total width of 1100 mm (45"), as the total width of the seat is less than 3 x 410 mm = 1230 mm (50").

14.4 Entry and exit from seats

14.4.1

A seat within a low volume vehicle that has a permanent or fixed roof structure, must be located and positioned in such a way that there is sufficient room to enable each occupant to enter and exit the vehicle without assistance.

14.4.2

A low volume vehicle that has a permanent or fixed roof structure and more than one row of seats, must incorporate a ready means of entry and exit, by the most direct path practical, for all rear seat passengers by having either:

(a) *one or more doors adjacent to each row of seating; or*

(b) *an aisle space of a width of not less than 300 mm (12") from each row of seating to one or more doors; or*

(c) *one or more seats within each row of seating, other than the rear-most seating row, that folds or tilts forward.*

14.4.3

Where entrance and exit to a seat within a low volume vehicle is accessed across or past a folding or tilting seat section, the control to enable the folding or tilting of the seat or seat section must:

(a) *be positioned on the side of the seat nearest the adjacent door; and*

(b) *be within easy reach, and be able to be easily operated by any person relying on the control to assist in exiting the vehicle.*

Unstressed seat types and sources:

14.5 Unstressed seats from production vehicles

14.5.1

An unstressed seat from a production vehicle may be fitted to a low volume vehicle, provided that:

(a) *the vehicle to which the seat was originally fitted was manufactured in either:*

(i) *Australia on or after 1 January 1988; or*

14.5.1

An 'unstressed' seat is a seat that does not have any seatbelt anchorages attached to it, whereas a 'stressed' seat is a seat that has one or more seatbelt anchorages attached directly to the seat-frame. The seats in many modern production vehicles have at least one lap belt anchorage attached directly to the seat frame.

(ii) *the United States of America on or after 1 January 1968; or*

(iii) *Europe on or after 1 January 1974; or*

(iv) *Japan on or after 1 January 1983;*

and

(b) *the seat is attached so as to replicate, so far as is practicable, the installation method employed by the donor vehicle manufacturer; and*

(c) *the seat is not modified in such a way as to reduce the original strength or rigidity of the seat structure.*

14.6 After-market unstressed seats

14.6.1

An after-market unstressed seat may be fitted to a low volume vehicle, provided that the seat is:

(a) *designed specifically for automotive use; and*

(b) *manufactured by a company professionally engaged in the automotive seat manufacturing industry; and*

(c) *rigidly constructed; and*

(d) *in good condition.*

14.7 Custom one-off unstressed seats

14.7.1

A custom one-off unstressed seat may be fitted to a low volume vehicle, provided that the seat is either:

(a) able to be assessed as being at least as strong in comparison to a seat specified in 14.5 or 14.6, taking into account design, material specifications, and construction methods; or

(b) accompanied by documented evidence of engineering reports or test results to substantiate that the seat is able to meet the applicable loading requirements specified in LVVTA LVV Standard 185-00 (Seats and Seat Anchorages).

14.5.1

An unstressed seat can be used from a production vehicle other than those specified in 14.5.1(a) provided that the LVV Certifier is satisfied, on the basis of a thorough visual inspection, that the design and strength of the frame of the seat being used is comparable to a seat from a vehicle specified in 14.5.1(a).

14.6.1(c)

It can be established by assessing through a physical inspection, that the amount of fore/aft and twisting movement that can be achieved at the top of the seat back is minimal. A seat that meets a recognised motor-sport standard such as FIA or SFI meets this requirement.

14.7.1

Where a seat is constructed on a one-off basis using composite materials, other than straight-forward hand lay-up fibre-glass, a satisfactory level of competence in the use of the material types used in the construction of the seat may be required to be demonstrated or proven to the LVV certifier.

14.7.2

Any welding carried out in relation to any seat modification or construction in a low volume vehicle, must meet all welding requirements specified in 18.7 and 18.8 of 'Chapter 18 - Attachment Systems'.

14.7.1(b)

This LVV Standard is available free of charge from the LVVTA website, www.lvvta.org.nz

14.8 Unstressed seats from other sources

14.8.1

An unstressed seat from sources other than those specified in 14.5 to 14.7, including a custom one-off seat built into the body structure, may be fitted to a low volume vehicle, provided that there is a bulkhead or part of the outer body structure immediately behind the seat to support the seat in the event of a rearward impact, or a rebound load during a frontal impact.

14.8.1

This means, for example, that a 1950s seat could be used in something like an AC Cobra replica or a period special, providing the seat is against, or close to, the rear bulkhead, or part of the outer body structure.

Stressed seat types and sources:

14.9 Stressed seats from production vehicles

14.9.1

A stressed seat from a production vehicle may be fitted to a low volume vehicle, provided that:

(a) *the vehicle to which the seat was originally fitted was manufactured in either:*

(i) *Australia on or after 1 January 1988; or*

(ii) *the United States of America on or after 1 January 1968; or*

(iii) *Europe on or after 1 January 1974; or*

(iv) *Japan on or after 1 January 1983;*

and

(b) *any seatbelt anchorages that are fitted to the seat frame were installed by the manufacturer of the seat; and*

(c) *the seat is not modified in such a way as to reduce the original strength or rigidity of the seat structure.*

14.9.1

A 'stressed' seat is a seat that has one or more seatbelt anchorages attached directly to the seat-frame. The seats in many modern production vehicles have at least one lap belt anchorage attached directly to the seat frame.

Other seat requirements:

14.10 Head restraints

14.10.1

A head restraint, if fitted to a seat in a low volume vehicle, must either:

(a) be a part of a seat from a production vehicle specified in 14.5 or part of an aftermarket seat specified in 14.6; or

(b) meet the requirements specified for head restraints in LVVTA LVV Standard 185-40 (Head Restraints).

14.10.1

A head restraint is not mandatory, however, if fitted, a head restraint must comply with 14.10.1.

14.10.1(b)

This LVV Standard is available free of charge from the LVVTA website, www.lvvta.org.nz

14.11 Seat hinging and latching mechanisms

14.11.1

A seat that was manufactured by a production vehicle manufacturer specified in 14.5 or 14.9, or by an aftermarket seat manufacturer specified in 14.6, that incorporates a latching mechanism to enable reclining, folding, or tilting, may be fitted to a low volume vehicle providing that:

(a) *the seat is not modified; and*

(b) *the positioning and attachment of the seat replicates as closely as practicable the positioning and attachment of the seat in its original application.*

14.11.2

A seat, as specified in 14.11.1, fitted to a low volume vehicle that reclines, folds, or tilts, must incorporate a hinging and latching mechanism that:

(a) *holds the seat securely in the latched position; and*

(b) *operates smoothly and freely; and*

(c) *in the case of a latching system;*

(i) *locks into place automatically; and*

(ii) *can be readily accessed and operated; and*

(iii) *releases easily.*

14.12 Seat situations not catered for in this chapter

14.12.1

In addition to the requirements specified in this chapter, the applicable requirements of LVVTA LVV Standard 185-00 (Seats and Seat Anchorages) must be met in the case of a low volume vehicle that either:

(a) has specialised seats for a person with a disability; or

(b) has seats attached to an area where there is a false floor between the seats and the vehicle floor; or

(c) is a vehicle being operated as a passenger service vehicle; or

(d) has seats fitted in an open or enclosed cargo area; or

(e) has a seat that was not manufactured by a production vehicle or recognised aftermarket manufacturer, which incorporates a hinging and latching mechanism to enable reclining, folding, or tilting; or

(f) is fitted with a quick-release seat; or

(g) is fitted with a rearward-facing seat; or

(h) is fitted with a sideways-facing seat; or

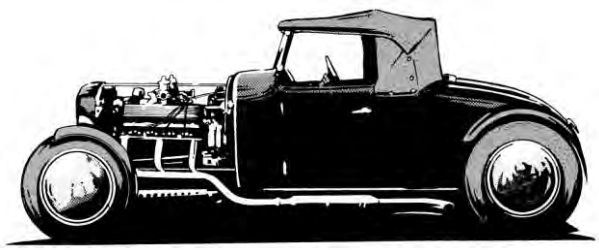
(i) is fitted with a swivelling seat; or

(j) is fitted with a custom one-off or aftermarket stressed seat; or

(k) is fitted with a stressed seat from a production vehicle that has an upper seatbelt anchorage incorporated within the seat frame.

14.12.1

This LVV Standard is available free of charge from the LVVTA website, www.lvvta.org.nz



General seat attachment requirements:

14.13 General attachment requirements for all seats

14.13.1

A seat that is fitted to a low volume vehicle must be attached in a manner that provides no less strength and durability than would be expected to be provided for the applicable seat style, weight, configuration, and location, by a modern production vehicle manufacturer.

14.13.1

Wherever possible, a seat should be attached to, or as close as possible to, a chassis or sub-frame section, or other load-bearing structural member.

The location or attachment method must be strong enough to support 20 times the weight of the seat.

14.13.2

A seat that is fitted to a low volume vehicle must not be attached directly to, or be supported by, a floor that is made of any type of wooden material, including plywood.

14.13.3

A seat base in a low volume vehicle must be securely located or attached so that it cannot move forward or rearward, or become dislocated, during an impact.

14.13.4

The surface of the area of a low volume vehicle to which a seat or any part of a seat attachment system attaches, must be free from any sound deadening or other compressible material to ensure that a full metal-to-metal contact is made.

14.13.5

Packers made from a mild steel material must be used as spacers to eliminate compressible air-gaps and ensure that a metal-to-metal contact is made where a seat or any part of a seat attachment system attaches to an uneven surface in a low volume vehicle such as a floor-pan with corrugations.

14.13.6

Where a part of the vehicle structure that is double-skinned lies between a seat and the opposite side of the structure of the low volume vehicle to which the seat attaches, and a packer cannot be inserted, the panel skins must be pulled firmly together to eliminate any air gaps between the skins.

14.13.7

Air gaps between two floor or panel surfaces of a low volume vehicle, to which a seat is fitted, may not be modified by hammering to avoid the necessity for installing packers.

14.13.8

The installation and attachment of a seat to a low volume vehicle must not involve any associated modifications that could weaken the vehicle structure.

Seat fastening and welding requirements:

14.14 Unstressed seat attachment

14.14

An 'unstressed' seat is a seat that does not have any seatbelt anchorages attached to it, whereas a 'stressed' seat is a seat that has one or more seatbelt anchorages attached directly to the seat-frame. The seats in many modern production vehicles have at least one lap belt anchorage attached directly to the seat frame.

14.14.1

An unstressed seat attached directly to the chassis (or sub-frame), or load-bearing cross-members in a low volume vehicle, must incorporate:

(a) as far toward the outer corners of the seat frame structure as practicable, not less than four fasteners of equal or greater size and strength than either:

(i) 5/16 inch UNF grade-5 imperial; or

(ii) 8 mm grade-8.8 metric;

and

(b) bracketry and mounting systems that follow time-proven best practice methods, and incorporate good design and construction techniques.

14.14.2

An unstressed seat attached to a panel steel floor in a low volume vehicle, must be attached to the floor as far toward the outer corners of the seat frame structure as practicable, with:

(a) not less than four fasteners of equal or greater size and strength than either:

(i) 5/16 inch UNF grade-5 imperial; or

(ii) 8 mm grade-8.8 metric;

and

(b) for each fastener, either:

(i) a doubler plate assembly that meets the requirements specified for a doubler plate assembly in 14.19 to 14.22; or

(ii) in the case of a seat leg assembly that attaches directly to the vehicle floor and covers a floor surface area of not less than 3000 sq mm (122 sq "), with a width of not less than 30 mm (1 3/16"), under-floor mounting plates that meet the applicable requirements specified for under-floor mounting plates in 14.23 to 14.25.

14.15 Stressed seat attachment

14.15.1

A stressed seat may be attached directly to the chassis (or sub-frame), or load-bearing cross-members in a low volume vehicle, provided that the attachment system incorporates:

(a) as far toward the outer corners of the seat frame structure as practicable, not less than four fasteners of equal or greater size and strength than either:

(i) 7/16 inch UNF grade-5 imperial; or

(ii) 12 mm grade-8.8 metric;

and

(b) bracketry and mounting systems that follow time-proven best practice methods, and incorporate good design and construction techniques.

14.15.2

A stressed seat may be attached to a panel steel floor of a low volume vehicle, provided that either:

(a) the requirements specified for the attachment of stressed seats in LVVTA LVV Standard 185-00 (Seats and Seat Anchorages) are met; or

(b) so far as is practicable, the installation method employed by the donor vehicle manufacturer is replicated, and the floor section to which the stressed seat is attached is either:

(i) comparable in specification to the floor of a vehicle that was designed by the manufacturer to be fitted with stressed seats; or

(ii) sufficiently reinforced so as to enable the floor to withstand the loads that could be applied to the floor section by the seat in the event of a frontal collision.

14.15

A 'stressed' seat is a seat that has one or more seatbelt anchorages attached directly to the seat-frame. The seats in many modern production vehicles have at least one lap belt anchorage attached directly to the seat frame.

14.15.1

This applies only to stressed seats with a lower seatbelt anchorage buckle attached to the seat frame. Any seat with an upper seatbelt anchorage attached to the seat frame must comply with LVV Standard 185-00.

This LVV Standard is available free of charge from the LVVTA website, www.lvvta.org.nz

14.15.2(a)

This LVV Standard is available free of charge from the LVVTA website, www.lvvta.org.nz

14.16 Seat fastener requirements

14.16.1

A fastener used for the attachment of a seat in a low volume vehicle must:

(a) *be lightly coated with lubricant over the threaded section; and*

(b) *have its tensile strength grade identified in order to establish the correct torque setting for the fastener (see Table 14.1); and*

(c) *be tightened to the applicable torque setting specified in Table 14.1.*

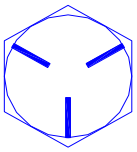
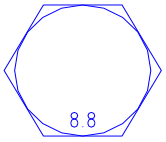
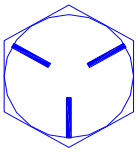
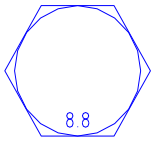
FASTENER GRADE	MARKING	SURFACE	TORQUE
5/16" Grade 5 imperial		un-plated	26 Nm (19 ft lb)
		plated	24 Nm (17.7 ft lb)
8 mm Grade 8.8 metric		un-plated	26 Nm (19 ft lb)
		plated	24 Nm (17.7 ft lb)
7/16" Grade 5 imperial		un-plated	51 Nm (37 ft lb)
		plated	48 Nm (35 ft lb)
12 mm Grade 8.8 metric		un-plated	89 Nm (65 ft lb)
		plated	83 Nm (61 ft lb)

Table 14.1 Seat fastener grade and torque settings

14.17 Seat fastening through hollow sections

14.17.1

A seat anchorage fastener that is required to be positioned through a hollow section such as a chassis rail, sub-frame section, or cross-member in a low volume vehicle, must incorporate a crush-tube to enable correct tightening of the anchorage fastener without causing deformation of the section through which the anchorage fastener passes, that:

(a) *is constructed from a mild steel material, with a nominal wall thickness of 3 mm (1/8"); and*

(b) *is coated, together with the structure or surface to which the crush-tube attaches, with a permanent anti-corrosive protection such as paint or zinc plating; and*

(c) *provides a metal-to-metal contact throughout the span of the seat anchorage fastener's attachment.*

14.18 Seat attachment welding requirements

14.18.1

14.18.1

In the case of fabricated bracketry and mounting systems used to attach a seat to the body structure of a modified production low volume vehicle by welding, the bracketry and mounting systems must follow time-proven best practice methods, and incorporate good design and construction techniques.

Welding seat bracketry to the gearbox tunnel and outer sills is a common and acceptable method of attaching seats into motor-sport vehicles.

14.18.2

All welding carried out in relation to any seat mounting in a low volume vehicle, must meet all welding requirements specified in 18.7 and 18.8 of 'Chapter 18 - Attachment Systems'.

Seat anchorage doubler plates:

14.19

14.19 Seat doubler plate specifications

14.19.1

The idea of a doubler plate assembly is to use two plates, one on top of the floor and one under the floor, attached to each other and the floor, to spread any impact load over a larger floor area, and to ensure that the anchorage remains in place if the seat is removed.

A doubler plate assembly used to attach a seat to a low volume vehicle must:

(a) *always consist of two plates, one on each side of the vehicle structure to which the seat is attached; and*

(b) *be constructed from a mild steel material, with a nominal plate thickness of 3 mm (1/8"); and*

(c) *have a hole within the outer plate to accommodate the seat anchorage bolt, that:*

(i) *has a bolt clearance of no greater than 1 mm (1/24"); and*

(ii) *is located as centrally as practicable on the plate surface;*

and

(d) *incorporate a permanently fixed nut or threaded section of steel material having a minimum full thread depth of 9.5 mm (3/8"), of equal or greater size than either:*

(i) *in the case of an unstressed seat, 8 mm or 5/16 inch UNF; or*

(ii) *in the case of a stressed seat, 12 mm or 7/16 inch UNF.*

14.19.1(d)

When a drilling and tapping operation is carried out on a section of steel, a visual inspection must be undertaken by a low volume vehicle certifier prior to final fastener installation, to ensure that adequate thread form has been provided in the material.

14.20 Seat doubler plate surface area

14.20.1

A doubler plate assembly used to attach a seat to a low volume vehicle must be of a size and orientation that enables a minimum mating area to which both doubler plate surfaces contact, of 3000 sq mm (122 sq "), with not less than 30 mm (1 3/16") in width, which include those plate mating areas specified in Table 14.2.

80 mm x 50 mm (3 ¼" x 2")
100 mm x 30 mm (4" x 1 ¼")
100 mm x 40 mm (4" x 1 ¾")
140 mm x 40 mm (5 ¾" x 1 ¾")

Table 14.2 Seat doubler plate mating surface area

14.21 Seat doubler plate preparation

14.21.1

A doubler plate assembly used to attach a seat to a low volume vehicle must:

(a) *have all corners rounded to a radius of no less than 5 mm (3/16"); and*

(b) *have all edges which contact the vehicle structure to which the doubler plate attaches rounded by the removal of no less than 0.1 mm (1/24"); and*

(c) *be coated, together with the structure or surface to which the doubler plate attaches, with a permanent anti-corrosive protection such as paint or zinc plating.*

14.21.2

The surface of the area of a low volume vehicle to which a doubler plate assembly is used to attach a seat must be free from any sound deadening or other compressible material to ensure that a full metal-to-metal contact is made.

14.22 Seat doubler plate attachment

14.22.1

A doubler plate assembly used to attach a seat to a low volume vehicle must be aligned as closely as practical to parallel to the longitudinal centre-line of the vehicle. (see Diagram 14.1)

14.22.1

The alignment of the doubler plates must be such that the direction of pull during loading will not be applied against a corner of the plates.

14.22.2

A doubler plate assembly used to attach a seat to a low volume vehicle must be securely attached to the vehicle structure by a mechanical means, which must be positioned parallel to the longitudinal centre-line of the vehicle, and evenly distributed over the plate surface area, and may be either: (see Diagram 14.1)

(a) not less than two and not more than four mild steel Monel rivets, which:

(i) are no less than 3.2 mm (1/8") in diameter; and

(ii) are no less than 3.2 mm (1/8") longer than the combined thickness of the materials through which the rivet passes;

or

(b) not less than two and not more than four 5 mm (3/16") bolts; or

(c) not less than two and not more than four 5 mm (3/16") plug-welds or spot welds.

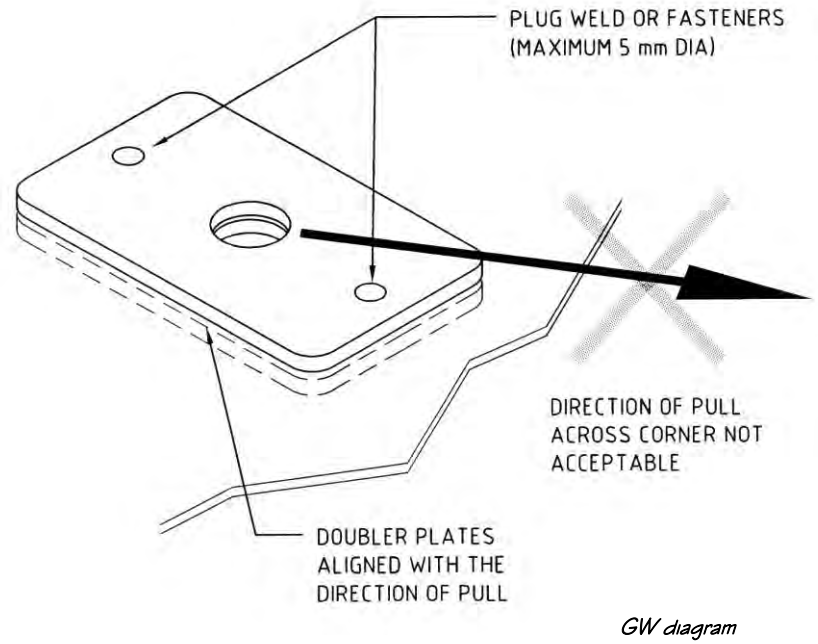


Diagram 14.1 Seat doubler plate attachment

Diagram 14.1

The two plates don't have to mirror each other – they can be of slightly different sizes and orientations, provided that the minimum area requirement for each plate is met.

The term 'fasteners' includes rivets.

14.22.3

A doubler plate assembly used to attach a seat to a low volume vehicle must be clamped together as tightly as practicable.

14.22.4

The attachment of a seat anchorage doubler plate assembly in a low volume vehicle must not involve any associated modifications that could weaken the vehicle structure.

Seat anchorage under-floor mounting plates:

14.23 Seat under-floor mounting plate specifications

14.23.1

An under-floor mounting plate used to attach a seat to a low volume vehicle, must:

(a) *be positioned on the opposite side of the vehicle structure to which the seat is attached; and*

(b) *be constructed from mild steel, with a nominal plate thickness of 3 mm (1/8"); and*

(c) *have a hole to accommodate the seat attachment bolt, that:*

(i) *has a bolt clearance of no greater than 1 mm (1/24"); and*

(ii) *is located as centrally as practicable on the plate surface;*

and

(d) *incorporate a permanently fixed nut or threaded section of steel material having a minimum full thread depth of 9.5 mm (3/8"), of equal or greater size than either:*

(i) *in the case of an unstressed seat, 8 mm or 5/16" UNF; or*

(ii) *in the case of a stressed seat, 12 mm or 7/16" UNF.*

14.24 Seat under-floor mounting plate surface contact area

14.24.1

An under-floor mounting plate used to attach a seat to a low volume vehicle must be of a size and orientation that enables a minimum surface contact area of 3000 sq mm (122 sq "), with not less than 30 mm (1 3/16") in width, which include those mounting plate surface contact areas specified in Table 14.3.

80 mm x 50 mm (3 ¼" x 2")
100 mm x 30 mm (4" x 1 ¼")
100 mm x 40 mm (4" x 1 ¾")
140 mm x 40 mm (5 ¾ x 1 ¾")

Table 14.3 Seat under-floor plate mating surface area

14.25 Seat under-floor mounting plate attachment

14.25.1

An under-floor mounting plate used to attach a seat to a low volume vehicle must be aligned as closely as practical to parallel to the longitudinal centre-line of the vehicle.

14.25.2

An under-floor mounting plate used to attach a seat to a low volume vehicle must be securely attached to the vehicle structure by a mechanical means, which must be aligned as closely as practical to parallel to the longitudinal centre-line of the vehicle, and evenly distributed over the plate surface area, and may be either:

(a) not less than two and not more than four mild steel Monel rivets, which:

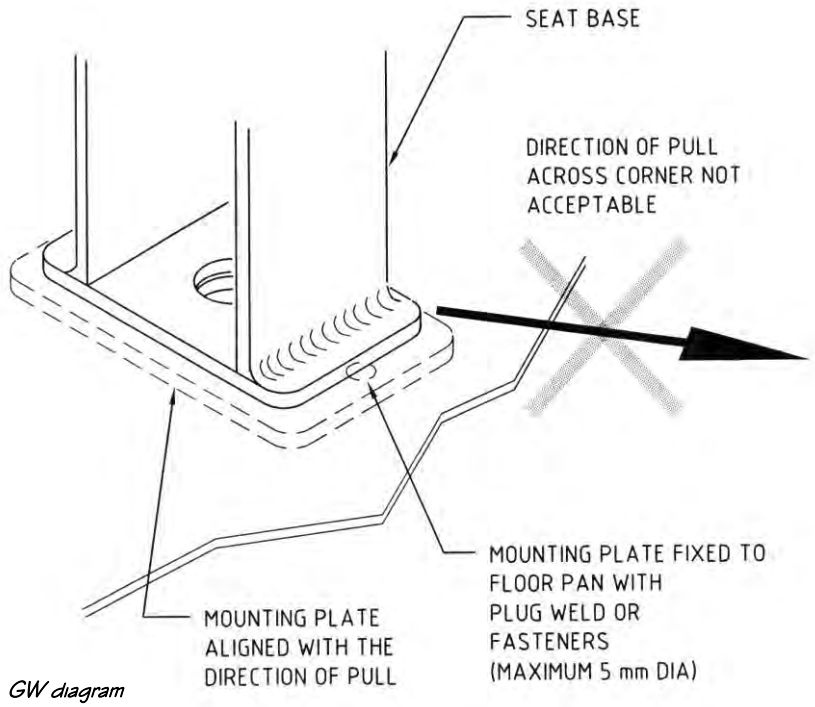
(i) are no less than 3.2 mm (1/8″) in diameter; and

(ii) are no less than 3.2 mm (1/8″) longer than the combined thickness of the materials through which the rivet passes;

or

(b) not less than two and not more than four 5 mm (3/16″) bolts; or

(c) not less than two and not more than four 5 mm (3/16″) plug-welds or spot welds.



GW diagram

Diagram 14.2 Seat under-floor mounting plate attachment

14.25.1

The alignment of the mounting plate must be such that the direction of pull during loading will not be applied against a corner of the plate.

Diagram 14.2

The term 'fasteners' includes rivets.

Seat attachment on uneven surfaces:

14.26 Seat doubler plate and under-floor mounting plate attachment on uneven surfaces

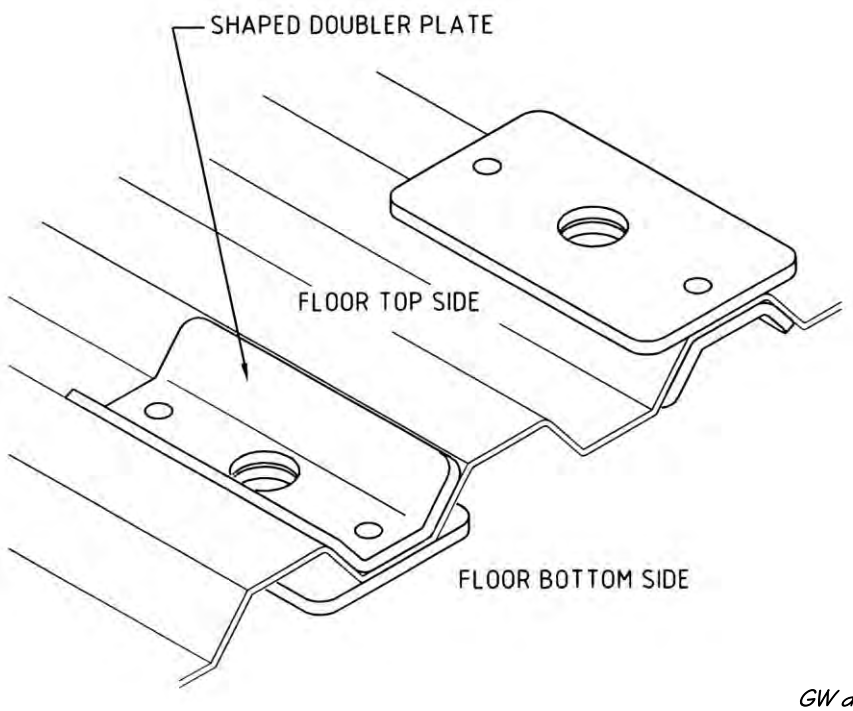
14.26.1

A doubler plate assembly or an under-floor mounting plate used to attach a seat to a low volume vehicle, where there is an uneven surface such as a floor-pan with corrugations, must maintain the required mating surface area, by either:

(a) where the doubler plate or under-floor mounting plate interferes with changes in the contour of the floor, be shaped to conform to the floor contour changes (see Diagram 14.3); or

14.26.1

The top plate on a 'peak' section, and a bottom plate on a 'valley' section, are not required to follow the shape of the floor surface providing the minimum contact areas are maintained.



GW diagram

Diagram 14.3 Doubler plates or underfloor mounting plates attached to uneven surfaces

(b) be supported by a packer that meets the requirements specified for packers in the LVVTA LVV Standard 185-00 (Seat and Seat Anchorages), positioned between the floor surface and the doubler plates or under-floor mounting plates.

14.26.1(b)

This LVV Standard is available free of charge from the LVVTA website, www.lvvta.org.nz

14.26.2

Where a doubler plate assembly or under-floor mounting plate is used to fit a seat to a section of a low volume vehicle where two or more panel skins lie between the two doubler plates or under-floor mounting plate, and a packer cannot be inserted, the skins must be pulled firmly together to eliminate any air gaps between the skins.

Other seat attachment requirements:

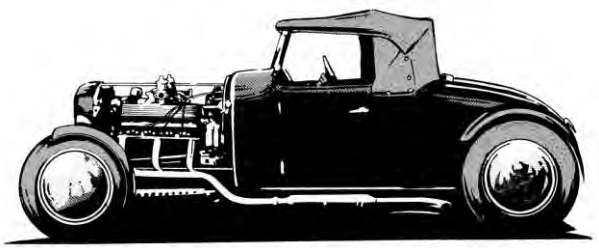
14.27 Seat attachment situations not covered in this chapter

14.27.1

In addition to the requirements specified in this Chapter, the applicable attachment requirements of LVVTA LVV Standard 185-00 (Seats and Seat Anchorages) must be met in the case of a low volume vehicle that has a seat specified in 14.12.

14.27.1

This LVV Standard is available free of charge from the LVVTA website, www.lvvta.org.nz



Seatbelt requirements:

14.28 Types of seatbelts required to be fitted

14.28.1

A seatbelt fitted to a low volume vehicle must be of a type specified for the seating position by Land Transport New Zealand, dependent on the vehicle's date of manufacture, date of first registration in New Zealand, Land Transport Table-A class, and in some cases other factors as may be applicable to special vehicles or circumstances.

14.29 Approved standards for seatbelts

14.29.1

A seatbelt fitted to a low volume vehicle must comply with one or more of the approved standards specified in Table 14.4.

14.28

These details are not listed in this manual because of the complexity of the subject, and the amount of space it would take up. A vehicle builder should consult an LVV Certifier early on, or refer to Section 7-5 of the 'Vehicle Inspection Requirements Manual: In-service certification', via the New Zealand Transport Agency website.

Purchase seatbelts only from reputable automotive parts suppliers or specialist seatbelt installers.

APPROVED STANDARD	ABBREVIATION
▪ Council Directive 77/541/EEC of 28 June 1977 on the approximation of the laws of the Member States relating to safety belts and restraint systems on motor vehicles	Capital 'E' inside a circle
▪ UN/ECE Regulation No. 16, Uniform provisions concerning the approval of safety belts and restraint systems for adult occupants of power-driven vehicles (E/ECE324-E/ECE/TRANS/505/Rev.1/Add.15)	(Applies to military vehicles only)
▪ Federal Motor Vehicle Safety Standard No. 209, Seat Belt Assemblies	FMVSS 209
▪ Australian Design Rule 4, Seat Belts	ADR 4
▪ Technical Standard for Seat Belt Assemblies (Japan)	JIS D4604
▪ Japanese Industrial Standard D 4604-1988, Seat Belts for Automobiles	JIS D4604
▪ New Zealand Standard 5401:1982, Specification for seat belt assemblies for motor vehicles	NZS 5401
▪ Australian Standard/New Zealand Standard 2596:1995, Specification for seat belt assemblies for motor vehicles	AS/NZS 2596
▪ South African Bureau of Standards 1080-1983, Standard specification for restraining devices (safety belts) for occupants of adult build in motor vehicles (Revised requirements)	SABS 1080

Table 14.4 Seatbelt approved standards table

14.30 Seatbelt condition requirements

14.30.1

A seatbelt fitted to a low volume vehicle must:

(a) be in good condition and operate correctly; and

(b) be securely attached to the seatbelt anchorage; and

(c) incorporate buckle and tongue assemblies that lock and release easily; and

(d) be protected from the entry of foreign matter.

14.30.2

Seatbelt webbing in a seatbelt fitted to a low volume vehicle must not:

(a) be ripped, frayed, or torn; or

(b) be stretched or damaged by impact loading; or

(c) faded to the extent that the colour has been bleached; or

(d) incorporate any stitching that has become damaged or undone; or

(e) dyed post-manufacture; or

(f) repaired or modified in any way.

14.30

Note that seatbelt components must be part of a matched set; – in other words, you can't use a buckle from one seatbelt set with a tongue from a seatbelt set of a differing make, or one that meets a different standard.

14.30.1

Buying seatbelts that have come from an old vehicle or an accident damaged vehicle should be avoided – ultra-violet light degradation and impact loading can both cause damage and weakening to seatbelt webbing that isn't always visible.

14.31 Seatbelts in old vehicles and scratch-built vehicles

14.31.1

A web-clamp inertia reel retractor lap and diagonal seatbelt must be fitted for each front outboard seating position, and a lap seatbelt must be fitted for each front centre seating position and each rear seating position, in:

(a) every scratch-built low volume vehicle built after 2003, both with and without a fixed roof; and

(b) a modified production low volume vehicle, both with and without a fixed roof, that has undergone significant mechanical modifications, carried out for the specific purpose of achieving a substantial performance improvement, and thereby changing the vehicle's driving characteristics to more that of a modern vehicle.

A modified production low volume vehicle that was completed before 1 January 2009 is not required to comply with 14.31.1(b).

14.31.1

It is recognised that there are many situations where a web-clamp retractor seatbelt can't be used, because of the limited orientations for which they are designed (generally for mounting at the bottom of a B-pillar). If it is not practical to use a web-clamp retractor, a normal inertia-reel retractor lap and diagonal seatbelt must be used.

14.31.1(b)

See the note margin on the next page for details on 14.31.1(b).

14.32 Full-harness seatbelts

14.32.1

A three, four, five, or six point full-harness seatbelt may be fitted for the two front outer seating positions in a low volume vehicle, provided that the vehicle is issued with a current and valid LVV Authority Card, as specified in 'Chapter 3 – LVV Authority Cards'.

14.32.2

A three, four, five, or six point full-harness seatbelt may be fitted for the two front outer seating positions in a low volume vehicle, without the requirement for an LVV Authority Card, provided that:

(a) the vehicle:

(i) is a scratch-built low volume vehicle; and

(ii) has no more than one row of seats;

and

(b) the seatbelt meets either:

(i) one or more of the approved standards specified in Schedule 2 of the Land Transport Rule: Seatbelts and Seatbelt Anchorages 2002 (Rule 32011); or

(ii) an approved SFI or FIA standard applicable for international motor-sport purposes;

and

(c) all controls, both essential and non-essential to the driving operation of the vehicle, can be operated by the driver whilst in the normal driving position and with the seatbelt correctly adjusted; and

(d) a rear-view mirror is fitted to the interior, and one rear-view mirror is fitted externally to each side of the vehicle, all of which comply with the applicable requirements for rear-view mirrors in 'Chapter 15 – Glazing and Vision; and

(e) a head restraint is fitted for each seating position fitted with a full-harness seatbelt, that meets the requirements specified for head restraints in 14.10.

14.31.1(b)

See 'Seatbelts in old cars' in 'Useful Information' section at the end of this chapter to gain a clearer understanding of the types of vehicles that this requirement is aimed at.

This requirement is only aimed at vehicles built after 2009 where the seatbelt anchorages can be incorporated into the structure during the car's construction, and does not apply to a vehicle built prior to 2009 and then subsequently repowered.

14.32.1

See 'Chapter 3 – LVV Authority Cards' for eligibility criteria and approval details.

14.32.1 & 14.32.2

A three-point harness seatbelt is usually a retractable type. Note that the positioning of the upper anchorage for a 3-point full-harness seatbelt will differ from 4 or more point seatbelts, as the upper anchorage will need to be central to the seat.

14.33 Retractor positioning requirements

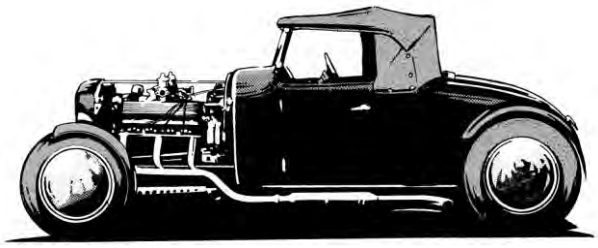
14.33.1

A retractor used within a seatbelt system fitted to a low volume vehicle must be mounted in a position that is not more than 5 degrees on either side of the operating angle of the retractor unit specified by the seatbelt manufacturer.

14.34 Interior trim requirements

14.34.1

Interior trim surrounding seatbelt anchorages fitted to a low volume vehicle must be positioned so that no rubbing or binding between the seatbelt and surrounding trim throughout all likely directions of pull of the seatbelt can occur.



General seatbelt anchorage requirements:

14.35 General requirements for all seatbelt anchorages

14.35.1

A seatbelt anchorage in a low volume vehicle must:

(a) attach to a permanent part of the vehicle structure such as a chassis or sub-frame rail, cross-member, pillar, floor section, or inner wheel arch; and

(b) not involve any modifications that could weaken the vehicle structure.

14.35.2

A seatbelt anchorage that is fitted to a low volume vehicle must not be attached directly to, or be supported by, a floor that is made of any type of wooden material, including plywood, or a combination of plywood and fibreglass.

14.35.3

A B-pillar into which an upper seatbelt anchorage is attached, in an old coach-built style modified production low volume vehicle, or a fibreglass-bodied scratch-built low volume vehicle, must be strengthened and reinforced as necessary, to ensure that the B-pillar, and the way in which it is attached to the vehicle structure, is as strong as the upper seatbelt anchorage itself.

14.35.3

See 'Upper seatbelt anchorage capping plates for pillar reinforcement' in the 'Useful Information' section at the back of this chapter for guidelines on how to achieve this.

14.35.4

Air gaps between two floor or panel surfaces of a low volume vehicle to which a seatbelt anchorage is attached, may not be modified by hammering to avoid the necessity for installing packers.

Seatbelt anchorage positioning:

14.36 Permitted area for upper seatbelt anchorages (vehicles with a permanent roof structure)

14.36.1

An upper seatbelt anchorage in a low volume vehicle with a permanent roof structure, must, where no anchorage was provided by the original vehicle manufacturer, or where the vehicle is a new scratch-built vehicle, be fitted in a position within the area specified in 14.36.2 to 14.38, determined by either:

(a) an LVVTA Body Frame; or

(b) measured from a LVVTA H-point template, as shown in Diagram 14.4.

14.36.1(a)

An LVV Certifier has an LVVTA Body Frame.

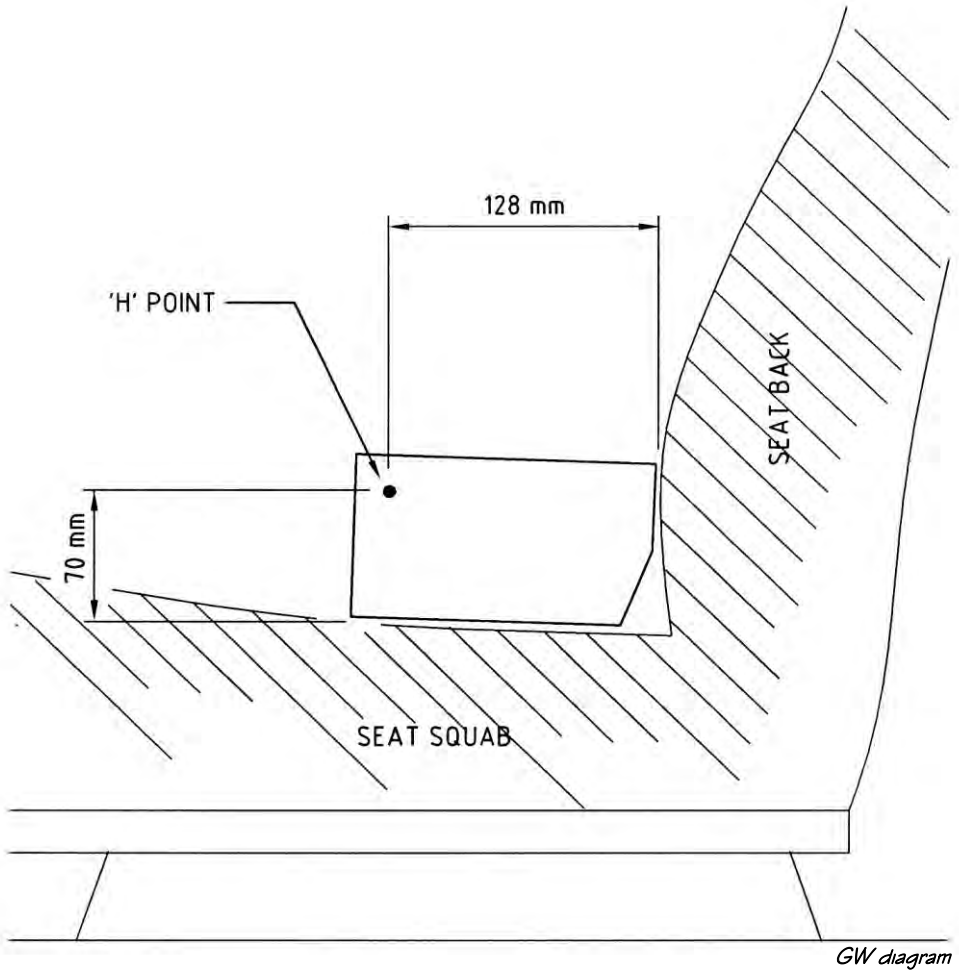


Diagram 14.4 LVVTA H-point template

14.36.2

With the seat at the mid-point of its fore-aft extension and the seat-back reclined to a normal driving position, an upper seatbelt anchorage in a low volume vehicle must be positioned:

(a) in the fore-aft direction, no further forward than a line that follows the front face of the seat back (see Diagram 14.5); and

(b) at a height of between 560 mm (22 ¾") and 710 mm (29"), measured from the H-point following the front face of the seat back (see Diagram 14.5); and

14.36.2(a)

It is important to have the upper anchorage positioned as far back as possible (provided that the seatbelt can be easily reached). This ensures that the belt is in the right position relative to the shoulder, and will therefore restrain the occupant during an impact.

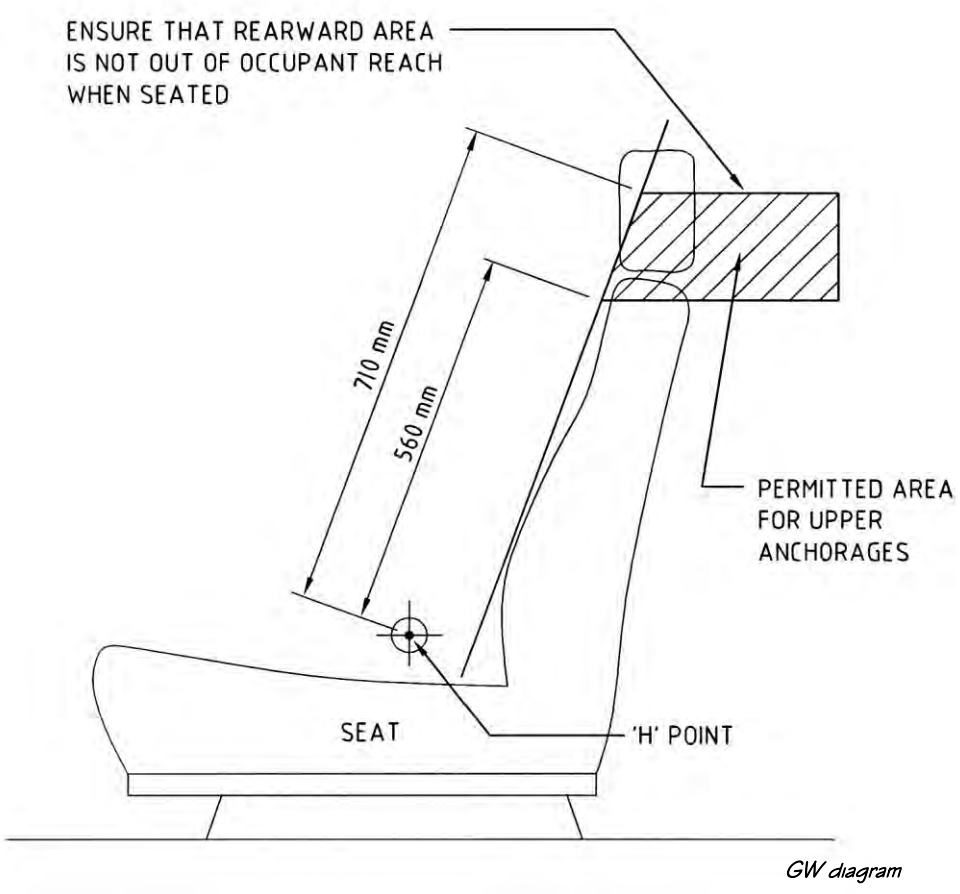


Diagram 14.5 Permitted area for upper anchorages (side view)

(c) at a width of between 140 mm (5¾") and 500 mm (20½") from the longitudinal centre-line of the seat. (see Diagram 14.6)

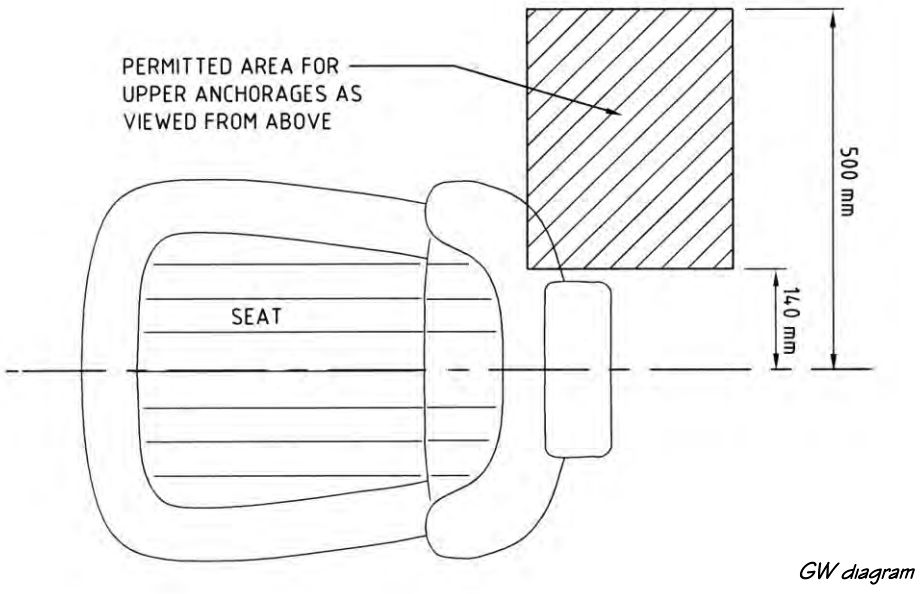


Diagram 14.6 Permitted area for upper anchorages (top view)

14.37 Permitted area for upper seatbelt anchorages in old vehicles

14.37.1

A low volume vehicle that has its B-pillar in such a position in relation to the seat, that the upper seatbelt anchorage cannot be positioned behind a line that follows the front face of the seat-back, must have the upper seatbelt anchorage positioned as close to the permitted area specified in 14.36.2(a) as is practically achievable.

14.37.1

Many older vehicles, particularly 1940s and earlier, have the B-pillar sitting beside, and even forward, of the seat back, which makes the correct positioning of the upper seatbelt anchorage virtually impossible, particularly on a 4-door vehicle.

14.38 Permitted area for upper seatbelt anchorages (vehicles with no permanent roof structure)

14.38.1

An upper seatbelt anchorage position in a low volume vehicle that does not have a permanent roof structure, and therefore cannot have the upper seatbelt anchorage positioned between 560 mm (22 ¾") and 710 mm (29") from the H-point, must be fitted in a position as close to the permitted area specified in 14.36.2(b) as is practically achievable.

14.39 Permitted area for lower seatbelt anchorages

14.39.1

A lower seatbelt anchorage in a low volume vehicle must, where no anchorage was provided by the original vehicle manufacturer or where the vehicle is a new scratch-built vehicle, be fitted in a position within the area specified in 14.39.2, determined by either:

(a) an LVVTA Body Frame; or

(b) measured from a LVVTA H-point template, as shown in Diagram 14.4.

14.39.1(a)

An LVV Certifier has an LVVTA Body Frame.

14.39.2

With the seat at the mid-point of its fore-aft extension and the seat-back reclined to a normal driving position, a lower seatbelt anchorage in a low volume vehicle must be positioned:

(a) in the fore-aft direction, rearwards from the H-point by between 17% and 100% of the distance between the H-point and the floor directly below the H-point (see Diagram 14.7); and

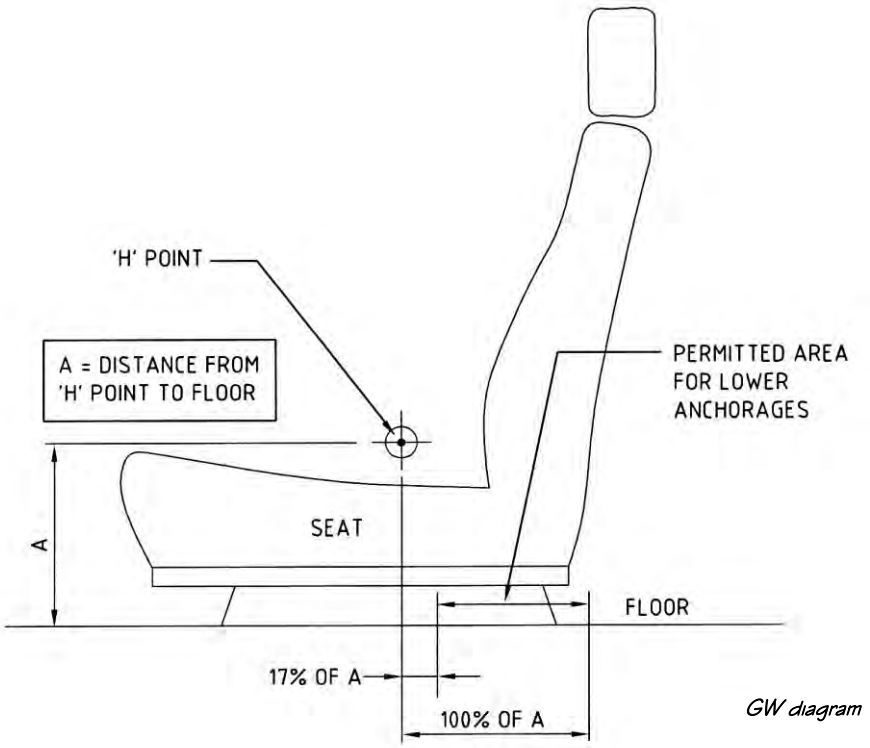


Diagram 14.7 Permitted area for lower anchorages (side view)

(b) at a width of no closer to each side of the centre-line of the seating position than 175 mm (7 1/8"), and no further from the centre-line of the seating position than 250 mm (10 ¼") (see Diagram14.8).

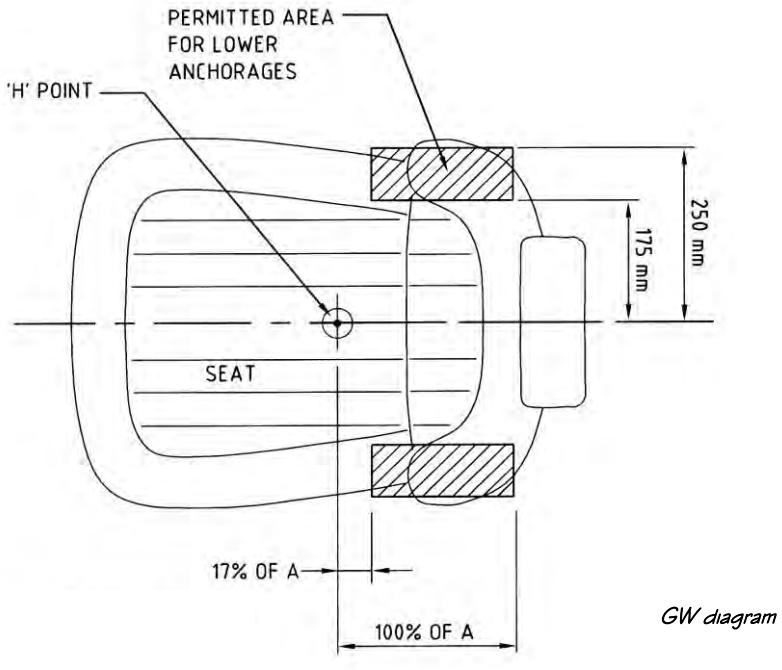


Diagram 14.8 Permitted area for lower anchorages (top view)

14.40 Permitted area for full harness seatbelt anchorages

14.40.1

A full-harness seatbelt fitted to a low volume vehicle must be positioned within the area specified by the applicable technical requirements of MotorSport New Zealand or the New Zealand Drag Racing Association, as appropriate to the type of vehicle to which the full harness is fitted.

Seatbelt anchorage fastening and welding requirements:

14.41 Fastening requirements for all seatbelt anchorages

14.41.1

14.41.1

A fastener used for the attachment of a seatbelt to a seatbelt anchorage in a low volume vehicle must be a fastener which is either:

(a) supplied by the manufacturer of the seatbelt being fitted; or

(b) of equal or greater size and strength than either:

(i) 7/16 inch UNF grade-5 imperial; or

(ii) 12 mm grade-8.8 metric.

In every seatbelt anchorage application possible, a bolt designed specifically for seatbelt anchorages should be used. Where it is necessary to use a different kind of bolt (such as where extra length is needed due to chassis rail through-bolting), a socket head cap-screw bolt must not be used, because of the small head area.

14.41.2

A fastener used for the attachment of a seatbelt to a seatbelt anchorage in a low volume vehicle must:

(a) incorporate a suitable size washer under the bolt head so as to spread the load of the anchorage against the bolt head in an impact; and

(b) where a seatbelt needs to be able to swivel, be a stepped bolt or incorporate a spacer; and

(c) be lightly coated with lubricant over the thread section; and

(d) have its tensile strength grade identified in order to establish the correct torque setting for the fastener (see Table 14.5); and

(e) be tightened to the applicable torque setting specified in Table 14.5.

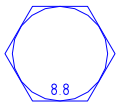
FASTENER GRADE	MARKING	SURFACE	TORQUE
7/16" Grade 5 imperial		un-plated	51 Nm (37 ft lb)
		plated	48 Nm (35 ft lb)
12 mm Grade 8.8 metric		un-plated	89 Nm (65 ft lb)
		plated	83 Nm (61 ft lb)

Table 14.5 Seatbelt fastener grade and torque settings

14.42 Seatbelt anchorage fastening through hollow sections

14.42.1

A seatbelt anchorage fastener that is required to be positioned through a hollow section such as a chassis rail (or sub-frame) or cross-member in a low volume vehicle, must incorporate a crush-tube to enable correct tightening of the anchorage fastener without causing deformation of the section through which the seatbelt anchorage fastener passes, that:

(a) *is constructed from a mild steel material, with a nominal wall thickness of 3 mm (1/8"); and*

(b) *is coated, together with the structure or surface to which the crush-tube attaches, with a permanent anti-corrosive protection such as paint or zinc plating; and*

(c) *provides a metal-to-metal contact throughout the span of the seatbelt anchorage fastener's attachment.*

14.43 Seatbelt anchorage welding requirements

14.43.1

In the case of fabricated bracketry and mounting systems used to attach a seatbelt anchorage to the body structure of a low volume vehicle by welding, the bracketry and mounting systems must follow time-proven best-practice methods, and incorporate good design and construction techniques.

14.43.2

All welding carried out in relation to any seatbelt anchorages in a low volume vehicle must meet all welding requirements specified in 18.7 and 18.8 of 'Chapter 18 - Attachment Systems'.

Seatbelt anchorage doubler plates:

14.44 Seatbelt anchorage doubler plate specifications

14.44.1

For all panel steel applications, other than those specified in 14.50 to 14.53, a doubler plate assembly must be used to attach a seatbelt anchorage to a low volume vehicle, which must:

(a) *always consist of two plates, one on each side of the vehicle structure to which the anchorage is attached; and*

(b) *be constructed from a mild steel, with a nominal plate thickness of 3 mm (1/8"); and*

(c) *have a hole within the outer plate to accommodate the seatbelt anchorage bolt, that:*

  (i) *has a bolt clearance of no greater than 1 mm (1/24"); and*

  (ii) *is located as centrally as practicable on the plate surface; and*

(d) *incorporate on the plate on the opposite side of the vehicle structure to the seatbelt, to accept a fastener specified in 14.41, a permanently fixed nut or threaded section of steel material having a minimum full thread depth of 9.5 mm (3/8"), of equal or greater size than either:*

  (i) *7/16 inch UNF imperial; or*

  (ii) *12 mm metric.*

14.45 Seatbelt anchorage doubler plate surface area

14.45.1

A doubler plate assembly used in a seatbelt anchorage in a low volume vehicle must be of a size and orientation that enables a minimum mating area to which both doubler plate surfaces contact, of 3000 square mm (122 sq "), with not less than 30 mm (1 3/16") in width, which include those plate mating areas specified in Table 14.6.

14.44

The idea of a doubler plate assembly is to use two plates, one on top of the floor and one under the floor, attached to each other and the floor, to spread any impact load over a larger area of floor, and to ensure that the anchorage remains in place if the seatbelt is removed.

14.44.1

'Panel steel applications' means where the anchorage is going into the floor or the pillar, as opposed to a chassis rail, cross-member, or roll-bar.

14.44.1(d)

When a drilling and tapping operation is carried out on a section of steel, a visual inspection must be undertaken by a low volume vehicle certifier prior to final fastener installation, to ensure that adequate thread form has been provided in the material.

80 mm x 50 mm (3 1/4 x 2")
100 mm x 30 mm (4" x 1 ¼")
100 mm x 40 mm (4" x 1 ¾")
140 mm x 40 mm (5 ¾" x 1 ¾")

Table 14.6 Seatbelt doubler plate mating surface area

14.46 Seatbelt anchorage doubler plate preparation

14.46.1

A doubler plate used to attach a seatbelt anchorage to a low volume vehicle must:

(a) *have all corners rounded to a radius of no less than 5 mm (3/16"); and*

(b) *have all edges which contact the vehicle structure to which the doubler plate attaches rounded by the removal of no less than 0.1 mm (1/24"); and*

(c) *be coated, together with the structure or surface to which the doubler plate attaches, with a permanent anti-corrosive protection such as paint or zinc plating.*

14.46.2

The surface of the area of a low volume vehicle to which a doubler plate assembly used to attach a seatbelt anchorage must be free from any sound deadening or other compressible material to ensure that a full metal-to-metal contact is made.

14.47 Seatbelt anchorage doubler plate attachment

14.47.1

A doubler plate assembly used to attach a seatbelt anchorage to a low volume vehicle must be aligned as closely as practical to parallel to the longitudinal centre-line of the vehicle.

14.47.2

A doubler plate assembly used to attach a seatbelt anchorage to a low volume vehicle must be securely attached to the vehicle structure by a mechanical means, which must be positioned parallel to the longitudinal centre-line of the vehicle, and evenly distributed over the plate surface area, and may be either: (see Diagram 14.9)

14.47.2

The alignment of the doubler plates must be such that the direction of pull during loading will not be applied against a corner of the plate.

(a) not less than two and not more than four mild steel Monel rivets, which:

(i) is no less than 3.2 mm (1/8″) in diameter; and

(ii) is no less than 3.2 mm (1/8″) longer than the combined thickness of the materials through which the rivet passes;

or

(b) not less than two and not more than four 5 mm (3/16″) bolts; or

(c) not less than two and not more than four 5 mm (3/16″) plug-welds or spot welds.

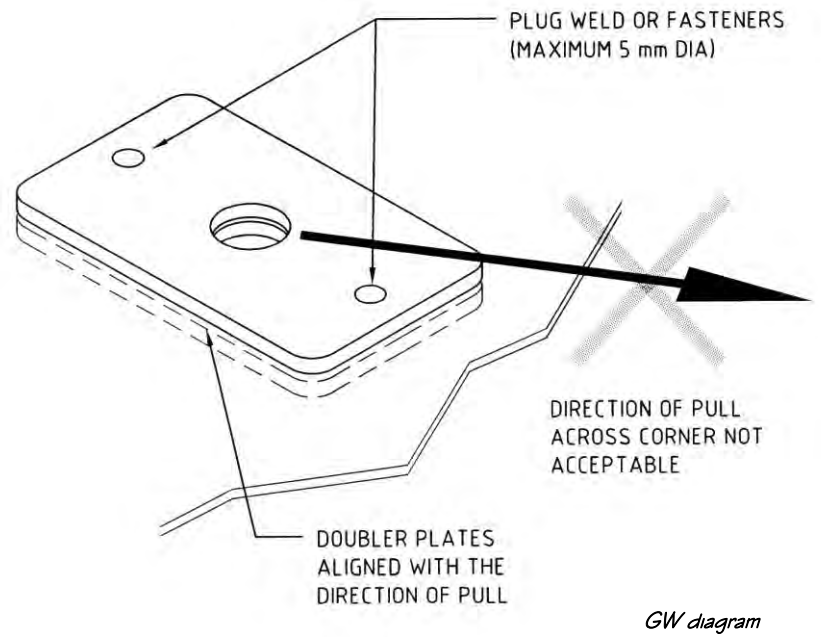


Diagram 14.9 Seatbelt anchorage doubler plate attachment

Diagram 14.9

The two plates don't have to mirror each other – they can be of slightly different sizes and orientations, provided that the minimum area requirement for each plate is met.

14.47.3

A doubler plate assembly used to attach a seatbelt anchorage to a low volume vehicle must be clamped together as tightly as practicable.

14.47.4

The attachment of a seatbelt anchorage doubler plate assembly in a low volume vehicle must not involve any associated modifications that could weaken the vehicle structure.

14.48 Seatbelt anchorage doubler plate attachment on uneven surfaces

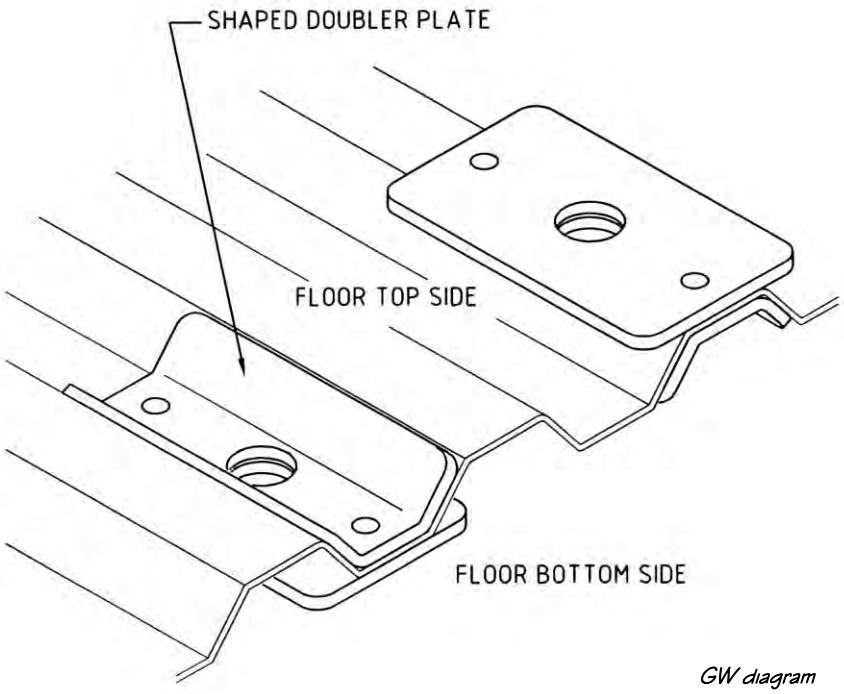
14.48.1

A doubler plate assembly used to attach a seatbelt anchorage to a low volume vehicle, where there is an uneven surface such as a floor-pan with corrugations, must maintain the required mating surface area, by either:

(a) where the doubler plate interferes with changes in the contour of the floor, be shaped to conform to the floor contour changes (see Diagram 14.10); or

14.48.1

The top plate on a 'peak' section and a bottom plate on a 'valley' section are not required to follow the shape of the floor surface providing the minimum contact areas are maintained.



GW diagram

Diagram 14.10 Seatbelt anchorage doubler plates attached to uneven surfaces

(b) be supported by a packer that meets the requirements specified for packers in the LVVTA LVV Standard 175-00 (Seatbelt Anchorages), positioned between the floor surface and the doubler plates.

14.48.1(b)

This LVV Standard is available free of charge from the LVVTA website, www.lvvta.org.nz

14.48.2

Where a doubler plate assembly is used to fit a seatbelt anchorage to a section of a low volume vehicle where two or more panel skins lie between the two doubler plates, and a packer cannot be inserted, the skins must be pulled firmly together to eliminate any air gaps between the skins.

14.49 Stiffening new sheet steel floors to support doubler plates

14.49.1

A low volume vehicle that has seatbelt anchorages attached to a custom-built floor that is made from mild steel sheet thinner than 1.2 mm (18-gauge), and does not incorporate any method of floor reinforcement such as rolled swages, or body seams or folds within 150 mm (6") in any direction from a doubler plate assembly, must have stiffeners fitted to the floor to support the doubler plate assemblies, that are: (see Diagram 14.11)

(a) positioned parallel to the longitudinal centre-line of the vehicle, and span the greatest distance as can be practically achieved; and

(b) positioned on the underside of the floor within 150 mm (6") of each doubler plate assembly; and

(c) attached to the floor by plug-welding at intervals of not more than 30 mm (1 3/16").

14.49.1

Suitably sized round tube, RHS, or C-section may be used. 25 mm x 25 mm (1" x 1") top-hat section is ideal.

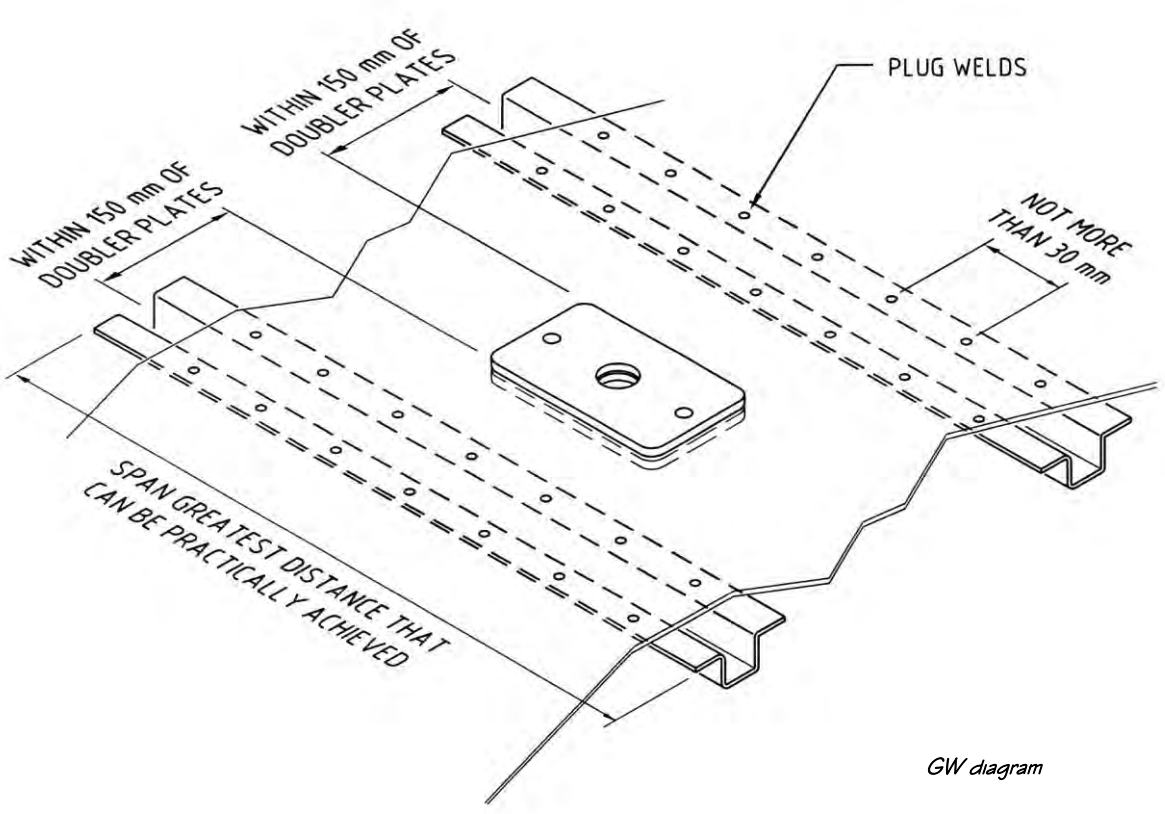


Diagram 14.11 Floor stiffeners to support seatbelt anchorage doubler plates

Alternatives to seatbelt anchorage doubler plates:

14.50 OE-style lower seatbelt anchorage mounting plates

14.50.1

An OE-style lower seatbelt anchorage under-floor mounting plate may be fitted to the floor in a low volume vehicle as an alternative to the requirement for doubler plates specified in 14.44 to 14.48, provided that:

(a) the under-floor mounting plates are either an original equipment item, or a reproduction part manufactured to original equipment specifications, and were intended for a vehicle of a similar era and construction type as the vehicle in question; and

(b) the vehicle manufacturer's method of attachment to the vehicle floor has been replicated as closely as can be practically achieved.

14.50.1

This type of anchorage is commonly used in restorations of 1950s and 1960s American vehicles. This means that the oval style of plate fitted to 1950s and '60s Chevrolets could be used on all vehicles of that era, provided that the vehicle floor is made from approximately the same type and thickness material as that which the plates were originally designed for.

14.51 Over-pillar upper seatbelt anchorage mounting plates

14.51.1

An over-pillar upper seatbelt anchorage mounting plate may be fitted to a B-pillar in a low volume vehicle as an alternative to the requirement for doubler plates specified in 14.44 to 14.48, in the case of where the B-pillar is too narrow or too extreme in shape to enable the use of a doubler plate system, provided that: (see Diagram 14.12)

(a) the same design, surface area, and preparation specifications required for doubler plates in 14.44 to 14.48 is achieved; and

(b) the permanently fixed nut or threaded section of steel referred to in 14.44.1(d) is recessed into the B-pillar; and

(c) the mounting plate is shaped to conform with the profile of the face of the B-pillar; and

(d) the mounting plate is fully welded around its circumference to the B-pillar.

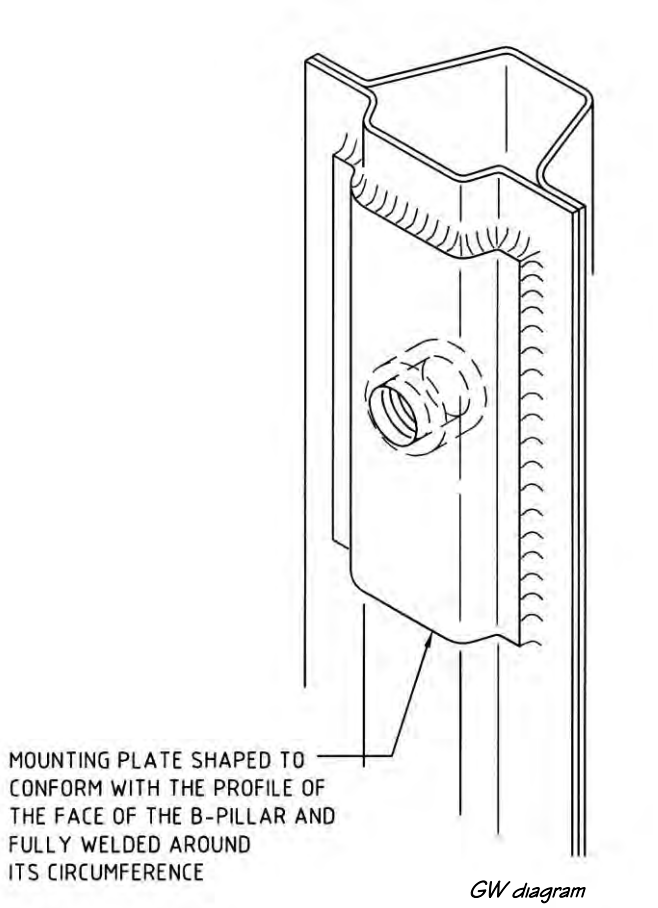


Diagram 14.12 Mounting plates for upper seatbelt anchorages in B-pillars

Diagram 14.12

Where this option is used, the panel seam or join in the surrounding structure 100 mm (4") above the top edge and 100 mm (4") below the bottom edge of the mounting plate must be reinforced at a spacing of between 30 mm (1 ¼") and 40 mm (1 ¾"), by plug welds of no less than 8 mm (5/16") in diameter, through a hole of no less than 8 mm (5/16") in diameter drilled in one skin only.

14.52 Inside-pillar upper seatbelt anchorage mounting plates

14.52.1

An inside-pillar upper seatbelt anchorage mounting plate may be fitted to a B-pillar in a low volume vehicle as an alternative to the requirement for doubler plates specified in 14.44 to 14.48, in the case of where the B-pillar is too narrow or too extreme in shape to enable the use of a doubler plate system, provided that: (see Diagram 14.13)

(a) the shape of the pillar is supported by additional material to achieve a plate assembly that is shaped to conform with the profile of the inside face of the B-pillar; and

(b) the cavity to allow the seatbelt anchorage bolt to attach to the mounting plate is minimised as much as is practically achievable.

14.52.1

9.5 mm (3/8") mild steel rod welded centrally down an 80 x 50 mm (3 ¼" x 2") plate works perfectly for many 1950s and '60s American vehicles, in particular mid-'50s Chevys.

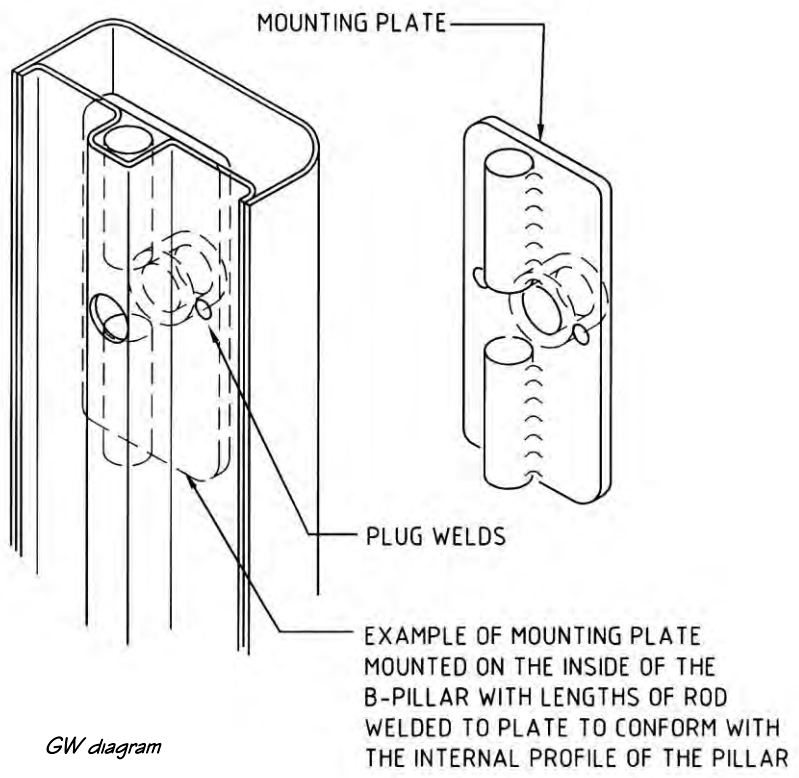


Diagram 14.13 Inside-pillar upper seatbelt anchorage mounting plate

Diagram 14.13

Where this option is used, the panel seam or join in the surrounding structure 100 mm (4") above the top edge and 100 mm (4") below the bottom edge of the mounting plate must be reinforced at a spacing of between 30 mm (1 ¼") and 40 mm (1 ¾"), by stitch welds of no less than 8 mm (5/16") in length.

14.53 Through-pillar upper seatbelt anchorage systems

14.53.1

A through-pillar upper seatbelt anchorage mounting system may be fitted to a B-pillar in a low volume vehicle as an alternative to the requirement for doubler plates specified in 14.44 to 14.48, in the case of where the B-pillar is too narrow or too extreme in shape to enable the use of a doubler plate system, provided that: (see Diagram 14.14)

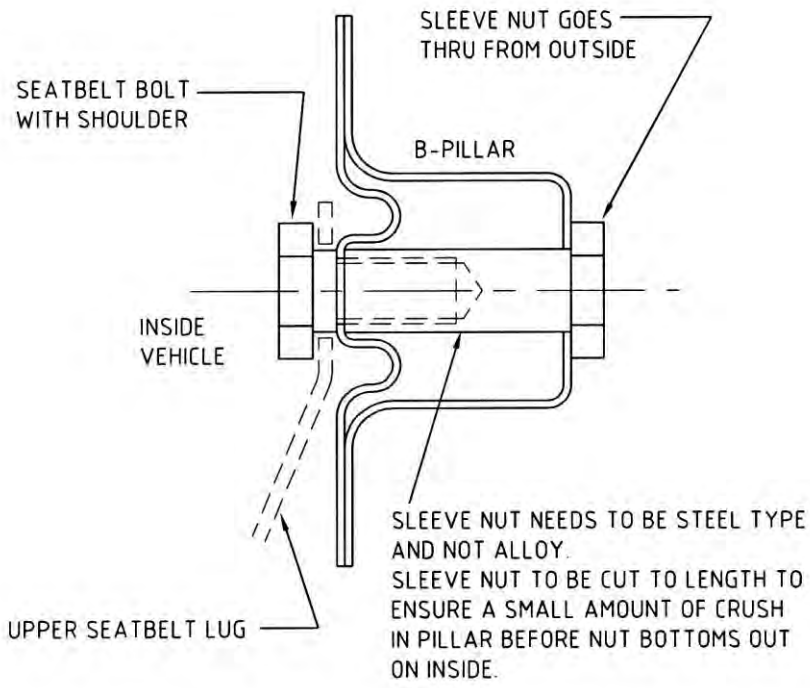
(a) the vehicle in question is a pre-1979 vehicle with substantially-constructed B-pillars; and

(b) the system is double-supported within the pillar, by the bolt head pressing against the external face on the outside of the pillar, and the steel sleeve pressing against the internal face on the inside of the pillar; and

(c) the sleeve is machined to fit snugly within the confines of the pillar, and has the pillar pre-loaded against it.

14.53

Note that an old through-pillar seatbelt anchorage installation that was carried out (retrospectively as a mandatory requirement under the then Ministry of Transport legislation) during the 1970s or '80s is not required to be LVV certified, and is not expected to meet these requirements if present on a vehicle that is being LVV certified today for other modifications.



GW diagram

Diagram 14.14 Through-pillar upper seatbelt anchorage systems

Seatbelt anchorage support frames:

14.54 Seatbelt anchorage support frame design

14.54.1

A support frame may be used for the attachment of an upper seatbelt anchorage in a low volume vehicle, provided that the support frame incorporates: (see Diagram 14.15)

(a) a main hoop made from a minimum of 38 mm x 2.5 mm (1 ½" x 3/32") wall thickness mild steel tubing; and

(b) diagonal bracing on each side of the main hoop made from a minimum of 38 mm x 2.5 mm (1 ½" x 3/32") wall thickness mild steel tubing, that:

(i) is positioned at a maximum angle from the main hoop of 70 degrees; and

(ii) contains the least amount of change in direction within any bends throughout its length as is practically achievable;

and

14.54

The seatbelt anchorage support frame design specified in 14.54.1 is aimed at providing a simple solution for those vehicles which do not have a steel body structure from which to attach an upper seatbelt anchorage, along with whatever reinforcement system is needed.

Types of vehicles for which this support frame design is intended are fibreglass bodies such as coupes, sedans, pick-ups, and roadsters, that don't have integral steel framing bonded directly to the body.

Typical early steel body structures can be used without this support frame design without the need for any verification.

14.54.1

Note that this specification does not necessarily comply with MotorSport New Zealand's roll-cage rules, or NZ Drag Racing Association rules. This needs to be considered if the vehicle is intended to be used for motor-sport or drag racing also.

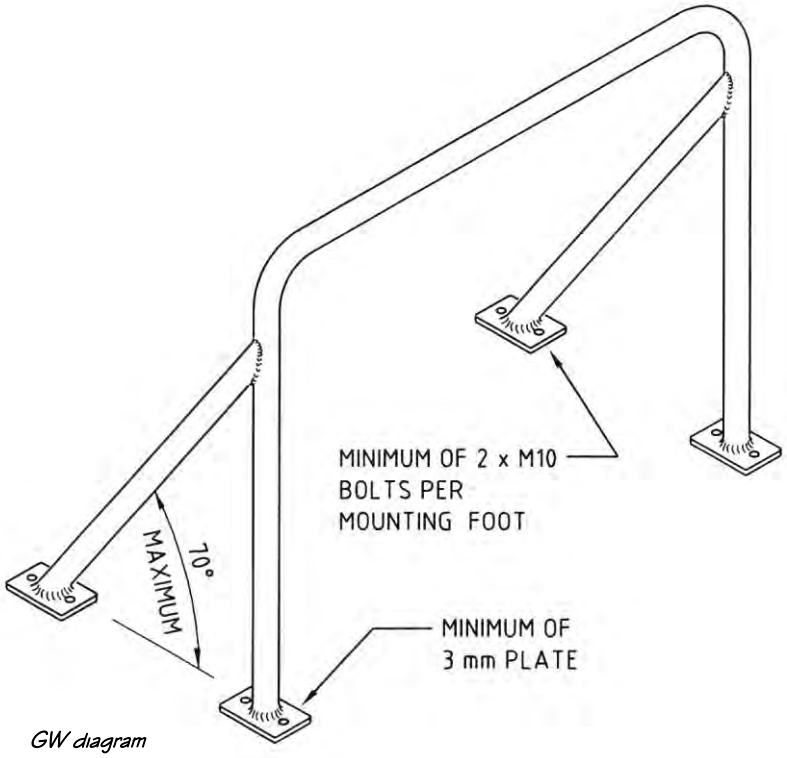
14.54.1(b)

Diagonal bracing can go either forward or rearward.

(c) incorporates a load-spreading foot, welded to the bottom of each support frame main hoop and diagonal brace section where it is positioned against the body structure, which is attached to the vehicle structure by either: (see Diagrams 14.16 and 14.17)

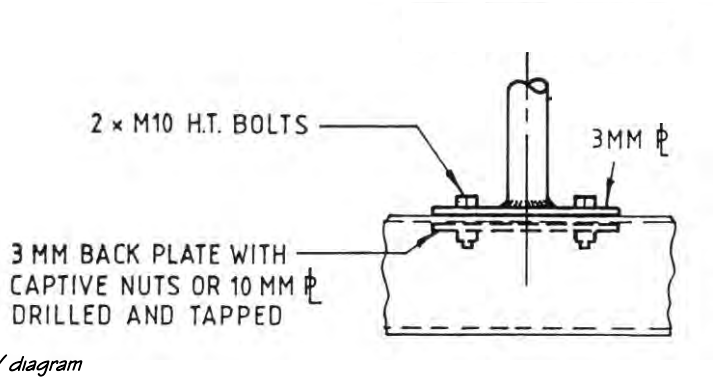
(i) not less than two 10 mm (3/8") fasteners with panel washers on the underside of the structure; or

(ii) welding to the vehicle structure around the circumference of each support frame foot.



GW diagram

Diagram 14.15 Seatbelt anchorage support frame design



GW diagram

Diagram 14.16 Support frame attachment for body/chassis vehicles

14.54.1(a) and (b)

Chrome-moly or stainless steel may be allowed, provided that the material provider or a suitably qualified expert can prove that the material strength is at least equivalent to the material specified in 14.54.1(a) or (b).

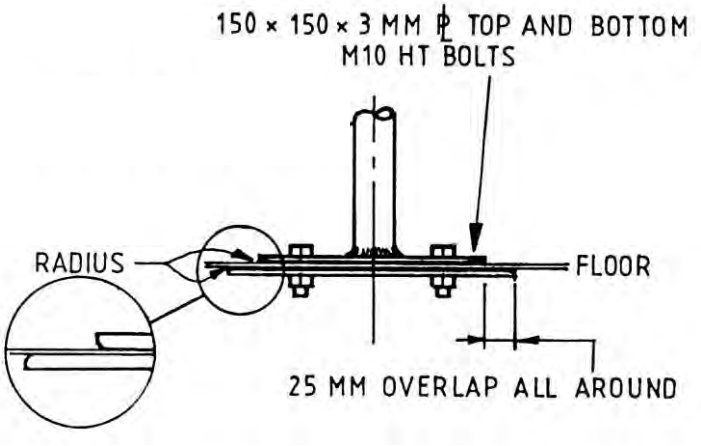
The LVV Certifier may elect to have the TAC independently verify documentation used to support that an alternative material is of equivalent strength.

14.54.1(c)

Note that both MotorSport NZ and NZ Drag Racing Association rules require a higher specification for fixing of feet to the vehicle structure than that specified here.

Diagram 14.16

As an alternative to washers, an under-floor mounting plate can be used.



GW diagram

Diagram 14.17 Support frame attachment for unitary constructed vehicles

Diagram 14.17

As an alternative to washers, an under-floor mounting plate can be used.

14.55 Seatbelt anchorage positioning on support frames

14.55

14.55.1

An upper seatbelt anchorage in a support frame in a low volume vehicle, may be a boss made from solid mild steel material of not less than 19 mm (3/4") diameter, drilled and tapped to accept a fastener specified in 14.41.1, having a thread depth of not less than 9.5 mm (3/8"). (see Diagram 14.18)

14.55.2

An upper seatbelt anchorage boss for a support frame in a low volume vehicle, as specified in 14.55.1, must be: (see Diagram 14.18)

(a) mounted in an east-west position to the longitudinal centre-line of the vehicle; and

(b) fully welded at both ends of the boss to the support frame; and

(c) positioned no further above the intersection point of the diagonal brace and the main hoop than:

(i) in the case of 38 mm (1 ½") tubing, 100 mm (4"); and

(ii) in the case of 44.5 mm (1 ¾") tubing, 150 mm (6"); and

(iii) in the case of 57 mm (2 ½") tubing, 200 mm (8").

A lug and boss assembly for a seatbelt anchorage could be successfully used on a support frame from a strength point of view (assuming the direction of pull was correct), however such anchorages (dependent on location and orientation) could introduce interior impact problems, and in many cases wouldn't be allowed because of that. For this reason, if using a lug instead of a boss, ensure that the relevant specifications provided in 14.61 and 14.62 are followed, and be sure that no interior impact problems are introduced as a result.

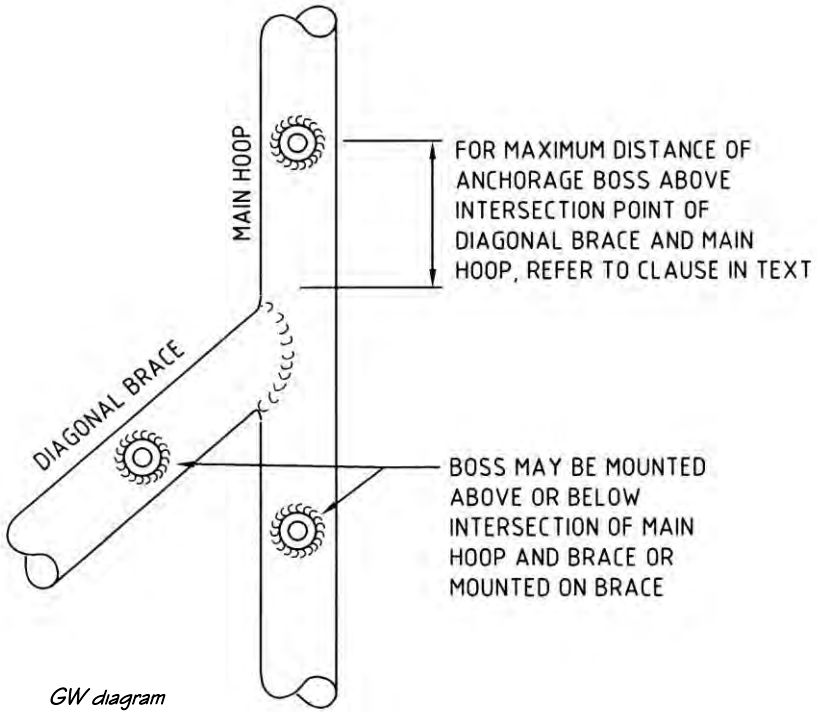


Diagram 14.18 Seatbelt anchorage boss in a support frame

Diagram 14.18

A gusset could be used to shift the effective intersection point between the main hoop and the diagonal brace.

14.56 Full harness seatbelt anchorage positioning on support frames

14.56.1

A low volume vehicle may use a bar that spans the width of the vehicle at the rear, to support two sets of full harness seatbelts, provided that:

(a) the bar used is mild steel tubing of not less than 38 mm x 2.5 mm (1 ½" x 3/32"); and

(b) fully welded at each end to either a support frame, or a substantial part of the vehicle structure; and

(c) some means is provided to prevent the seatbelt straps from sliding inward from their respective positions.

14.56.1

A support bar that spans the rear strut towers is common practice in motor-sport vehicles, particularly rally cars where a full harness is provided for both front seat occupants. This could also apply to a 2-seater sports car without a roll-bar or roll-cage, using a support frame specifically for the upper seatbelt anchorage attachment.

14.56.1 (a)

Chrome-moly or stainless steel may be allowed, provided that the material provider or a suitably qualified expert can prove that the material strength is at least equivalent to the material specified in 14.56.1(a).

Seatbelt anchorages into chassis rails & cross-members:

14.57 Chassis cross-members used to attach seatbelt anchorages

14.57.1

A set of inner and outer lower seatbelt anchorages for two occupants, (four seatbelt anchorages) may be attached to an unsupported cross-member that spans the chassis rails in a low volume vehicle, provided that: (see Diagram 14.19)

(a) the cross-member is fully welded to the chassis rail at each end; and

(b) the cross-member is made from a minimum of 50 mm x 50 mm x 3 mm (2" x 2" x 1/8") rectangular hollow section mild steel, or in the case of round tube, 60.3 mm x 3.6 mm (2 1/2" x 9/64") mild steel tubing; and

(c) in the case of where the span between the chassis rails is greater than 900 mm (37"), gussets made from 3 mm (1/8") mild steel are added to the front and rear of each join.

14.57.1

This specification differs dramatically from that in the original NZHRA Code of Construction Manual. In the original manual, additional diagonal support members were required, however, physical testing, supported by more calculation work, has shown that these additional diagonal braces are unnecessary.

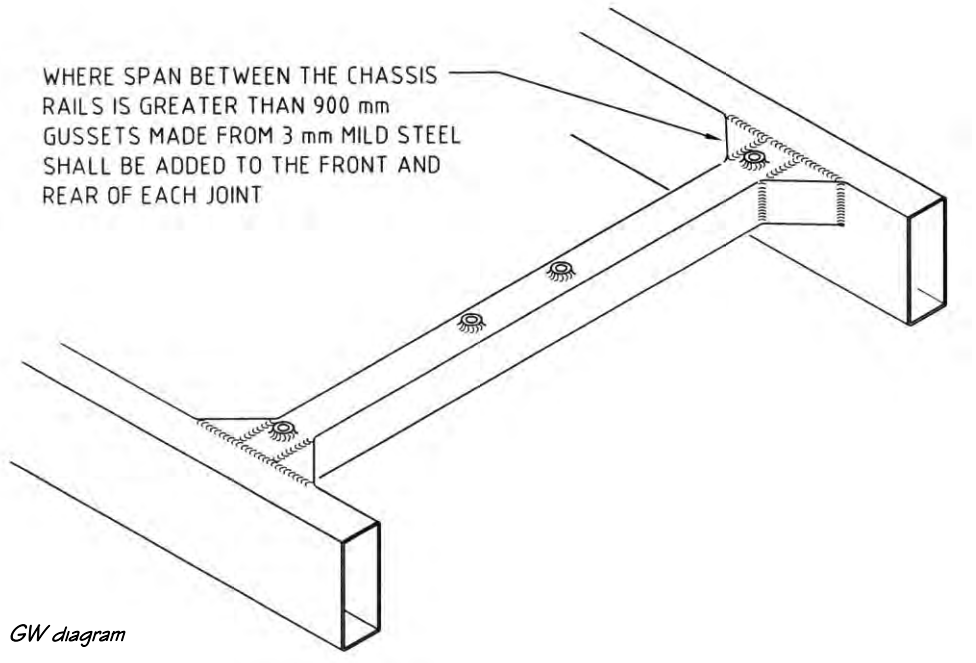


Diagram 14.19 Chassis cross-member used for seatbelt anchorages

14.57.2

A set of inner and outer lower seatbelt anchorages for three occupants, (six seatbelt anchorages) may be attached to an unsupported cross-member that spans the chassis rails in a low volume vehicle, provided that: (see Diagram 14.19)

(a) the cross-member is fully welded to the chassis rail at each end; and

(b) the cross-member is made from a minimum of 65 mm x 65 mm x 3 mm (2 ¾" x 2 ¾" x 1/8") rectangular hollow section mild steel, or in the case of round tube, 73 mm x 5.16 mm (3" x 13/64") mild steel tubing; and

(c) in the case of where the span between the chassis rails is greater than 900 mm (37"), gussets made from 3 mm (1/8") mild steel are added to both sides of each join.

14.57.2

If any other method or material specification is used, additional reinforcement must be provided via the interlinking of additional cross-members.

14.58 Seatbelt anchorage tapping plates inside chassis rails & cross-members

14.58.1

A seatbelt anchorage tapping plate may be welded to the inside of a channel-section or RHS chassis rail or cross-member in a low volume vehicle, provided that: (see Diagram 14.20)

(a) the tapping plate is made from a mild steel material that is not less than 50 mm x 20 mm (2" x 13/16"), and not less than 9.5 mm (3/8") thick; and

(b) the tapping plate is drilled and tapped to accept a fastener specified in 14.41.1; and

(c) the tapping plate is permanently attached to the chassis rail or cross-member by stitch-welding or plug-welding.

14.58.1

A seatbelt anchorage tapping plate can, if desired, also serve as a body mount as well as a seatbelt anchorage mount.

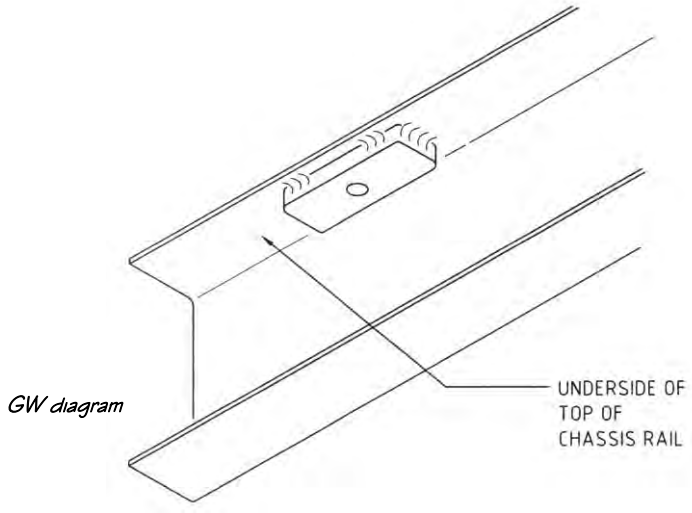


Diagram 14.20 Seatbelt anchorage tapping plates inside rail or x-member

14.59 Seatbelt anchorage tapping plates on top of chassis rails & cross-members

14.59.1

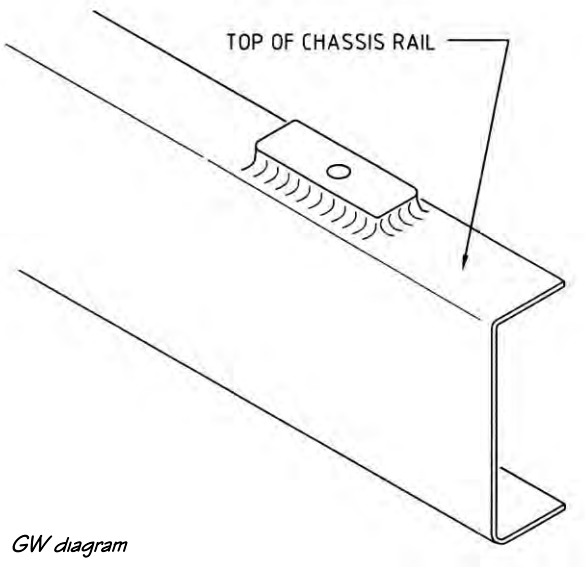
A seatbelt anchorage tapping plate may be welded on top of a channel-section or RHS chassis rail or cross-member in a low volume vehicle, provided that: (see Diagram 14.21)

(a) the chassis rail or cross-member is made from not less than 2.5 mm (3/32") wall thickness material; and

(b) the tapping plate is made from a mild steel material that is not less than 50 mm x 20 mm (2" x 13/16"), and not less than 9.5 mm (3/8") thick; and

(c) the tapping plate is drilled and tapped to accept a fastener specified in 14.41.1; and

(d) the tapping plate is fully welded to the chassis or cross-member around its total perimeter.



GW diagram

Diagram 14.21 Seatbelt anchorage tapping plate on rail or x-member

14.59.1

The seatbelt anchorage hole should be drilled and tapped through the chassis rail (or X-member) also, so that a combined threaded depth of around 12 mm (1/2") is achieved. This method also ensures that a 'blind' hole is avoided for the fastener to bottom out on.

A seatbelt anchorage tapping plate can, if desired, also serve as a body mount as well as a seatbelt anchorage mount.

14.60 Seatbelt anchorage bosses directly into chassis rails & cross-members

14.60.1

A seatbelt anchorage boss may be welded directly onto either the top or the bottom of a channel-section or RHS chassis rail or cross-member in a low volume vehicle, provided that: (see Diagram 14.22)

(a) the chassis rail or cross-member is made from 2.5 mm (3/32") or greater wall thickness material; and

(b) the boss is made from a mild steel material with a diameter of 19 mm (3/4") mm, and not less than 9.5 mm (3/8") thick; and

(c) the boss is drilled and tapped to accept a fastener specified in 14.41.1; and

(d) the boss is fully welded to the chassis or cross-member around its total circumference.

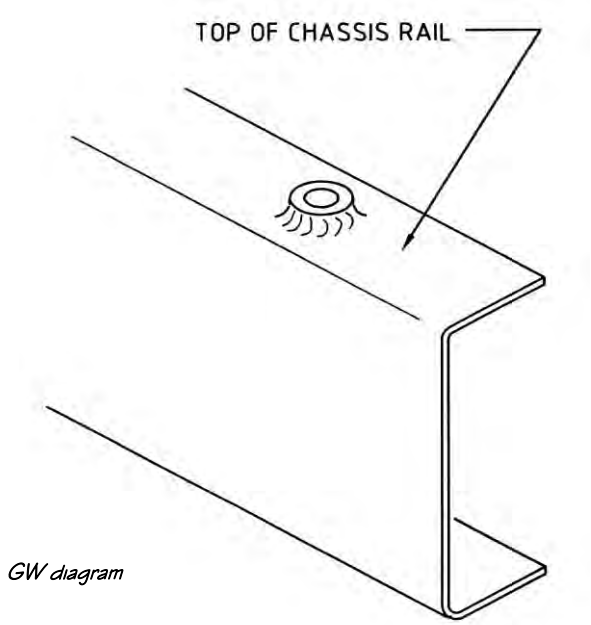


Diagram 14.22 Seatbelt anchorage boss on chassis rail or cross-member

14.60.1

The seatbelt anchorage hole should be drilled and tapped through the chassis rail (or X-member) also, so that a combined threaded depth of around 12 mm (1/2") is achieved. This method also ensures that a 'blind' hole is avoided for the fastener to bottom out on.

A seatbelt anchorage boss can, if desired, also serve as a body mount as well as a seatbelt anchorage mount.

Seatbelt anchorage lugs onto chassis rails & cross-members:

14.61 Chassis rail & cross-member lug and boss specification

14.61.1

A lug and boss assembly may be used to attach a seatbelt anchorage to a chassis rail or cross-member in a low volume vehicle by, provided that:

(a) the lug is made from 50 mm x 6 mm (2" x1/4") thick mild steel material; and

(b) the boss is made from a mild steel material with a diameter of 19 mm (3/4") mm, and not less than 9.5 mm (3/8") thick; and

(c) the boss is drilled and tapped right through to accept a fastener specified in 14.41.1; and

(d) the boss is fully welded to the lug around its total circumference.

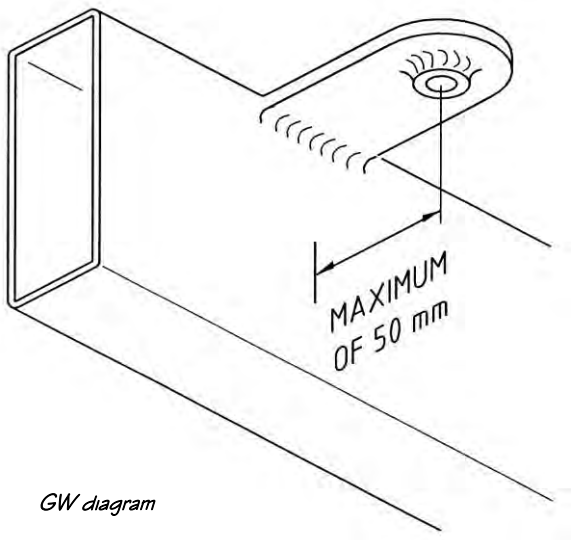
14.62 Lug and boss assemblies into chassis rails & cross-members

14.62.1

A seatbelt anchorage lug and boss assembly, as specified in 14.61.1, may be attached to a chassis rail or cross-member in a low volume vehicle without any additional support or gusseting, provided that: (see Diagram 14.23)

(a) the boss centre is positioned within 50 mm (2") of the chassis rail or cross-member; and

(b) the chassis rail or cross-member has a wall thickness of 3.0 mm (1/8") or more.



GW diagram

Diagram 14.23 Lug and boss assembly

14.62.2

A seatbelt anchorage lug and boss assembly, as specified in 14.61.1, may be attached to a chassis rail or cross-member in a low volume vehicle with the boss centre positioned within 75 mm (3") of the chassis rail or cross-member, provided that: (see Diagram 14.24)

14.62.2

On 3 mm (1/8") or heavier rails or members, the lug can be positioned anywhere within the depth of the rail or member, and the gusset spans the area above or below the lug back to the rail or member.

(a) the chassis rail or cross-member has a wall thickness of 3.0 mm (1/8") or more; and

(b) a 3 mm (1/8") vertical gusset extends from the lug to either the top or the bottom of the chassis rail or cross-member, depending on where within the depth of the chassis or cross-member the lug is positioned.

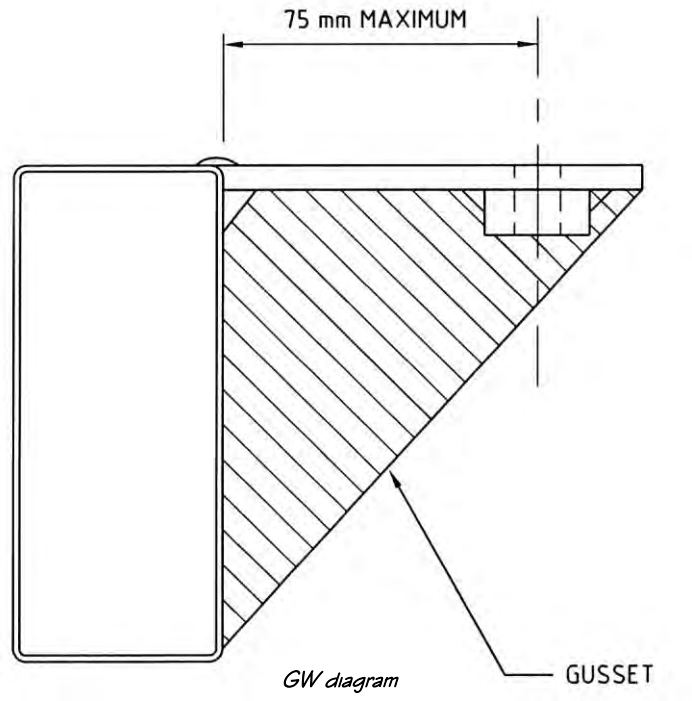


Diagram 14.24 Lug and boss assembly attachment to heavy wall section

14.62.3

A seatbelt anchorage lug and boss assembly, as specified in 14.61.1, may be attached to a chassis rail or cross-member in a low volume vehicle that has a wall thickness of less than 3.0 mm (1/8"), provided that: (see Diagram 14.25)

(a) the boss centre is positioned within 50 mm (2") of the chassis rail or cross-member; and

(b) the lug and boss assembly is positioned centrally within the depth of the chassis rail or cross-member, and fully welded to the chassis rail or cross-member; and

(c) a 3 mm (1/8") vertical gusset extends from the lug to the top and bottom of the chassis rail or cross-member.

14.62.3

On lighter than 3 mm (1/8") rails or members, the lug must be positioned centrally within the depth of the rail or member, and a gusset must span the area above and below the lug back to the rail or member.

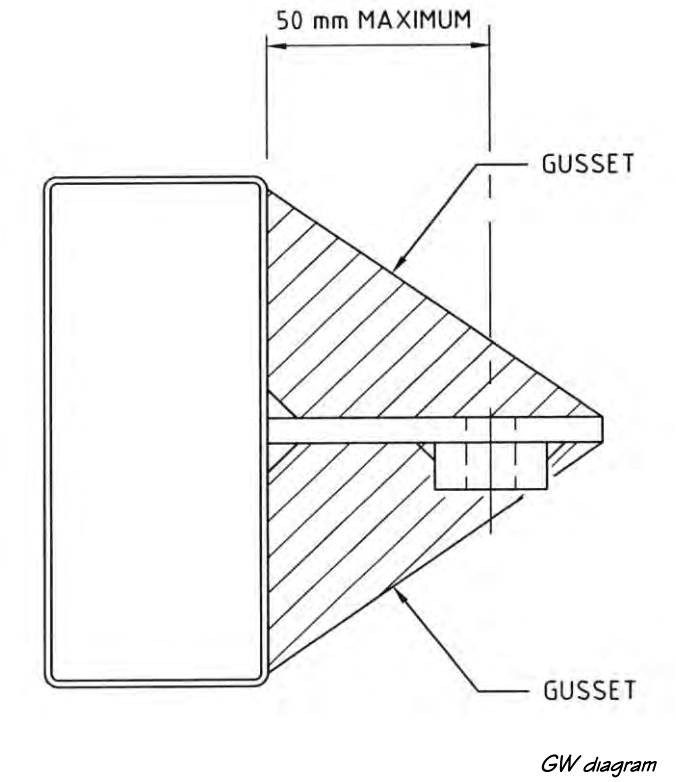


Diagram 14.25 Lug and boss attachment to light-to-medium wall section

14.63 Lug and boss assemblies onto space-frame chassis

14.63.1

A seatbelt anchorage lug and boss assembly, as specified in 14.61.1, may be attached to a section of light-wall space-frame chassis in a low volume vehicle, provided that: (see Diagram 14.26)

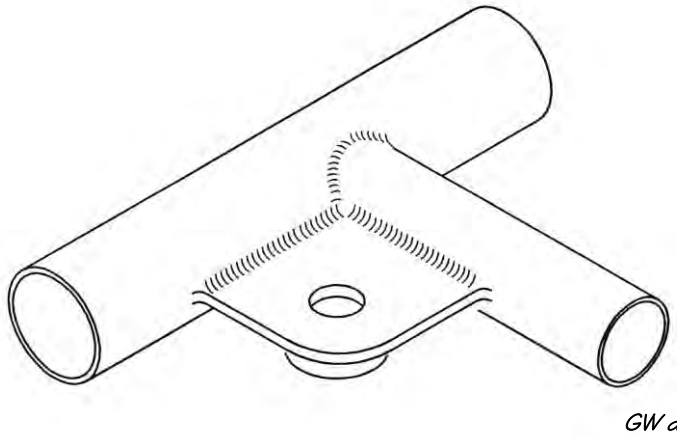
(a) the material specification for the lug is reduced to 50 mm x 3 mm (2" x 1/8"); and

(b) the lug and boss assembly is always positioned at the intersection of two or more of the space-frame chassis tubes; and

(c) gusseting is incorporated within the space-frame chassis tubes if the direction of load is not on the same plane as the lug and boss assembly.

14.63.1

As an alternative to 14.63, a seatbelt anchorage can be mounted to a space-frame chassis via the use of a boss mounted through a tube, provided that the boss is positioned at the intersection of two or more of the space-frame tubes.



GW diagram

Diagram 14.26 Lug and boss assembly to space-frame chassis

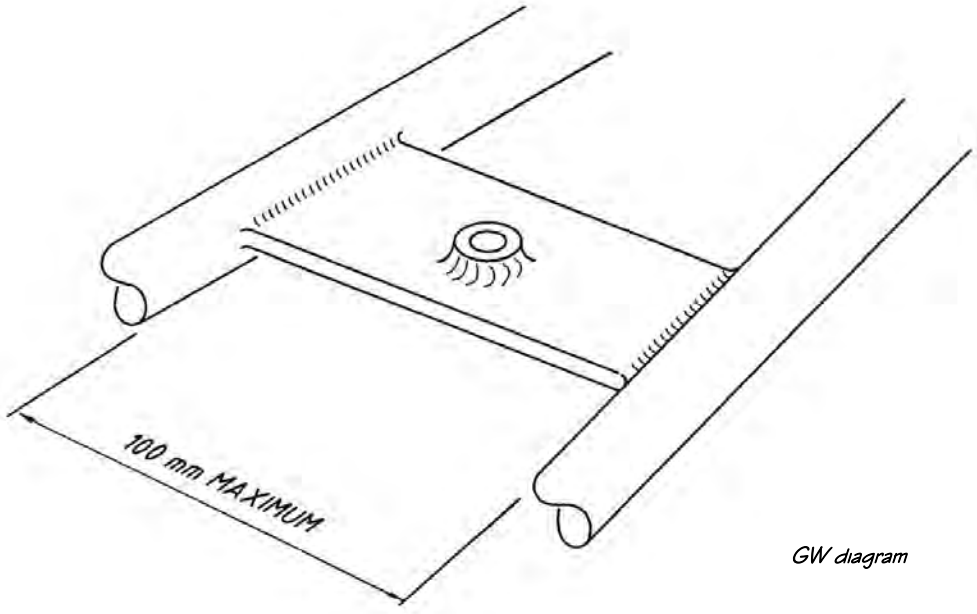
14.63.2

A seatbelt anchorage lug and boss assembly, as specified in 14.61.1, may span two tubes in a light-wall space-frame chassis in a low volume vehicle, provided that: (see Diagram 14.27)

(a) the material specification for the lug is reduced to 50 mm x 3 mm (2″ x 1/8″); and

(b) the total span between the two tubes does not exceed 100 mm (4″); and

(c) gusseting is incorporated if the direction of load is not on the same plane as the lug and boss assembly.



GW diagram

Diagram 14.27 Lug and boss assembly to space-frame chassis

Seatbelt anchorages into rear shelves:

14.64 Rear shelf reinforcement for upper seatbelt anchorages

14.64.1

14.64.1(a)(i)

Where an upper seatbelt anchorage is positioned onto a rear shelf of a low volume vehicle:

(a) the rear shelf must:

(i) be of such a shape, width, design, and material specification so as to be at least as strong as a rear shelf which a high volume vehicle manufacturer installs seatbelt anchorages into as original equipment; and

A rear shelf can be reinforced with RHS or similar, stitch-welded all along the rear shelf, and fully welded to a structural part of the vehicle at each outside end.

(ii) be supported at each side by a load-bearing structural member or section of the vehicle;

and

14.64.1(b)(ii)

The type of reinforcement necessary for a third upper anchorage would be a section of 40 x 40 x 3 mm (1 ¾" x 1 ¾" x 1/8") top hat section or similar, stitch-welded all along the rear shelf, and fully welded to a structural part of the vehicle at each outside end.

(b) the upper seatbelt anchorages fitted to the shelf must either:

(i) in the case of two outer upper seatbelt anchorages attached to the rear shelf, be attached within 100 mm (4") of a load-bearing structural member or section of the vehicle; or

(ii) in the case of a third upper seatbelt anchorage attached to the rear shelf provided for a centre seating position, that shelf must be suitably reinforced in order to withstand the loads that could be applied by the centre upper seatbelt.

Seatbelt anchorages into composite material:

14.65 Seatbelt anchorages into composite material

14.65.1

Where no steel structure exists within the permitted area for an upper seatbelt anchorage in a low volume vehicle, an upper seatbelt anchorage may be fitted into fibre-glass or other composite material, only provided that:

(a) an individual application is approved in writing by the Technical Advisory Committee, on a case-by-case basis, after having been satisfied by documented evidence, which may require test results, that the loadings specified within LVV Standard 175-00 (Seatbelt Anchorages) can be met; and

(b) the person carrying out the composite lay-up work has the appropriate level of expertise to be involved in this area of work.

Other seatbelt anchorage requirements:

14.66 Seatbelt anchorage situations not covered in this chapter

14.66.1

14.66.1

This LVV Standard is available free of charge from the LVVTA website, www.lvvta.org.nz

In addition to the requirements specified in this Chapter, the applicable requirements of LVVTA LVV Standard 175-00 (Seatbelt Anchorages) must be met in the case of:

(a) a seatbelt anchorage which is attached to the side-wall of a vehicle; or

(b) a vehicle that has specialised seatbelts for a person with a disability; or

(c) a vehicle that is fitted with a quick-release seatbelt anchorage; or

(d) where two seatbelts are attached to one seatbelt anchorage; or

(e) where seatbelts attach to an area where there is a false floor between the seatbelts and the vehicle floor; or

(f) where the permitted area for a seatbelt anchorage is over glazing, and a window bar or cant rail dropper is required.

Exclusions:

14.67 Upper seatbelt anchorages in older vehicles

14.67.1

A low volume vehicle is not required to be fitted with upper seatbelt anchorages if:

(a) the vehicle was manufactured before 1 November 1979; and

(b) was never originally designed by the vehicle manufacturer to be fitted with upper seatbelt anchorages; and

(c) either:

(i) no fixed roof exists within which to position an upper seatbelt anchorage within the permitted area for an upper seatbelt anchorage specified in 14.36 to 14.38; or

(ii) the B-pillar is of such dimensions, or of such a shape, so as to preclude the installation of a doubler plate assembly specified in 14.44 to 14.48 within the permitted area for an seatbelt anchorage specified in 14.36 to 14.38.

14.67.1

This exclusion is intended to apply primarily to pillarless classic motor vehicles of the 1950s and 60s.

Useful information

Seatbelt anchorage loadings

Some of the requirements in this chapter, particularly those for seatbelt anchorages, might look like overkill, but it's easy to under-estimate the forces at work during an impact when gravity takes hold of your body.

If you're an average healthy-sized 100 kg (220 lb) Kiwi bloke, the load your body-weight imposes on your seatbelt and seatbelt anchorages in an impact isn't 100 kg. During a sudden stop, inertia dictates that your body wants to keep going forward – just like if there was something loose on the back seat. In a 20 G impact (a 20G crash is considered survivable if luck is on your side), that inertia causes your body to effectively weigh 20 times more than it actually does, in the direction of the impact.

So, what the seatbelt and the combined seatbelt anchorages have to restrain, is not 100 kgs (220 lbs), but 100 kgs x 20, which equals 2000 kgs (4400 lbs).

When you think you've got your seatbelt anchorage system nutted out, ask yourself this hypothetical question – if I could somehow secure my car 9 metres (30 feet) up against the side of a building, facing nose down, and I could attach a set of strops or chains to one person's seatbelt anchorages, and then suspend a Holden Commodore from that one person's set of seatbelt anchorages, would I let my kids stand under that Commodore? That's obviously an over-simplistic way of looking at it, but those are the kind of massive loads at stake.

Seatbelts in old cars

The law of the land has always said that a vehicle manufactured before 1955 doesn't need to have seatbelts. The car hobby has ridden on the shirt-tail of this sweeping statement for many years, which when written, never really considered a Pre-'55 vehicle that's been substantially modified in the performance department.

If it came to a debate, it would be hard for the LVVTA or NZHRA to hold its hand on its heart, and say, from the point of view of a responsible organisation, that a 1928 Model-A Coupe with an IFS, IRS, R&P, TPI OHV engine, 700R overdrive auto trans, and big brakes, shouldn't have to be fitted with seatbelts because 'its an old car'. Why shouldn't it? Because the car's too rare to modify? Yeah, right! Because it's too difficult? C'mon! Do you really believe that?

The time has come to take a deep breath, and as responsible and sensible vehicle enthusiasts, accept that we need to engineer in some seatbelt anchorages as part of the project, even in our old steel cars. Most people involved in hot rodding, sports cars, and kit cars tend to be older these days, and are already putting in seatbelts because it's just plain dumb not to, so this new rule is only going to hurt a few. If you're one of those few, I'll promise you this – complying with this new rule won't hurt as much as getting in a head-on without lap and diagonal seatbelt.

Note that the requirement for lap and diagonal seatbelt in old modified production cars – as required by 14.31.1(b) - only applies to vehicles that have been significantly modified for substantial performance gains, to the extent that the car's driving characteristics are more like that of a modern car. Here's the basic intention: The Model-A Coupe with the hotted side-valve V8, dropped I-beam, and reversed Merc rims is not going to be required to be fitted with seatbelts, as whilst its been modified, the modifications aren't such that the car's old-timey driving characteristics have disappeared. Similarly, it is not the intention of the requirement to say that because someone has replaced the original 6-cylinder engine in their '59 Chev Impala with a V8 engine, the vehicle now requires lap and diagonal seatbelts.

This requirement applies where there has been a substantial increase in power, and where there has been a significant redesign of the vehicle's mechanicals. 'Substantial' horsepower gains can be loosely defined as where a vehicle's horsepower output has doubled or more. A 'significant redesign' of the vehicle's mechanicals can be loosely defined as where the suspension and steering configuration, and braking type have all been completely changed.

For example, the mechanicals of a 289-powered '48 Ford Sedan with disc brakes adapted, an F100 steering box fitted, and telescopic shocks fitted, haven't undergone a 'significant redesign'. That's just a few enhancements. A significant redesign would be where custom cross-members, an IFS, power rack, late-model column, and vented discs have been engineered into the '47 Ford.

Everyone involved in the LVV certification system is aware that this whole issue will be quite subjective on the odd occasion, so some vehicles will need to be considered on a case-by-case basis, and in these cases the LVV Certifier will talk to LVVTA to get a ruling.

Also, while lap and diagonal seatbelts are only mandated for the front outer seating positions, there's no better advice in this Car Construction Manual than to fit lap and diagonal seatbelts everywhere that you can. If you're building a sedan, then fit them in the rear outer seating positions, and even in the center rear seating position if you can – some older and wiser hot rodders have been doing this for years now.

Upper seatbelt anchorage capping plates for pillar reinforcement

Some early cars, pre-1940s sedans in particular, were never originally designed to have seatbelts fitted, and their B-pillars in particular are often not up to the job. In most cases, the B-pillar itself has plenty of strength – certainly enough for an upper seatbelt anchorage - but the problem lies in the way in which the B-pillar is attached to the roof and the floor or sill.

Upper and lower 'capping plates' need to be fitted at the attachment point of the B-pillar to the roof and floor or sill to strengthen those areas. The top capping plate can, if desired, extend down the pillar to provide the inner doubler plate for the seatbelt anchorage itself.

Existing timber framing may be left inside the B-pillars for added strength, or it can be removed and replaced with RHS framing, as most car builders tend to do as part of the overall repair and stiffening-up process.

Use Diagrams 14.28 to 14.30 as a guide to help you design your capping plates.

The upper seatbelt anchorage capping plates (as shown in Diagram 14.28) can be integrated within the steel inner framing as shown in diagram 14.30.

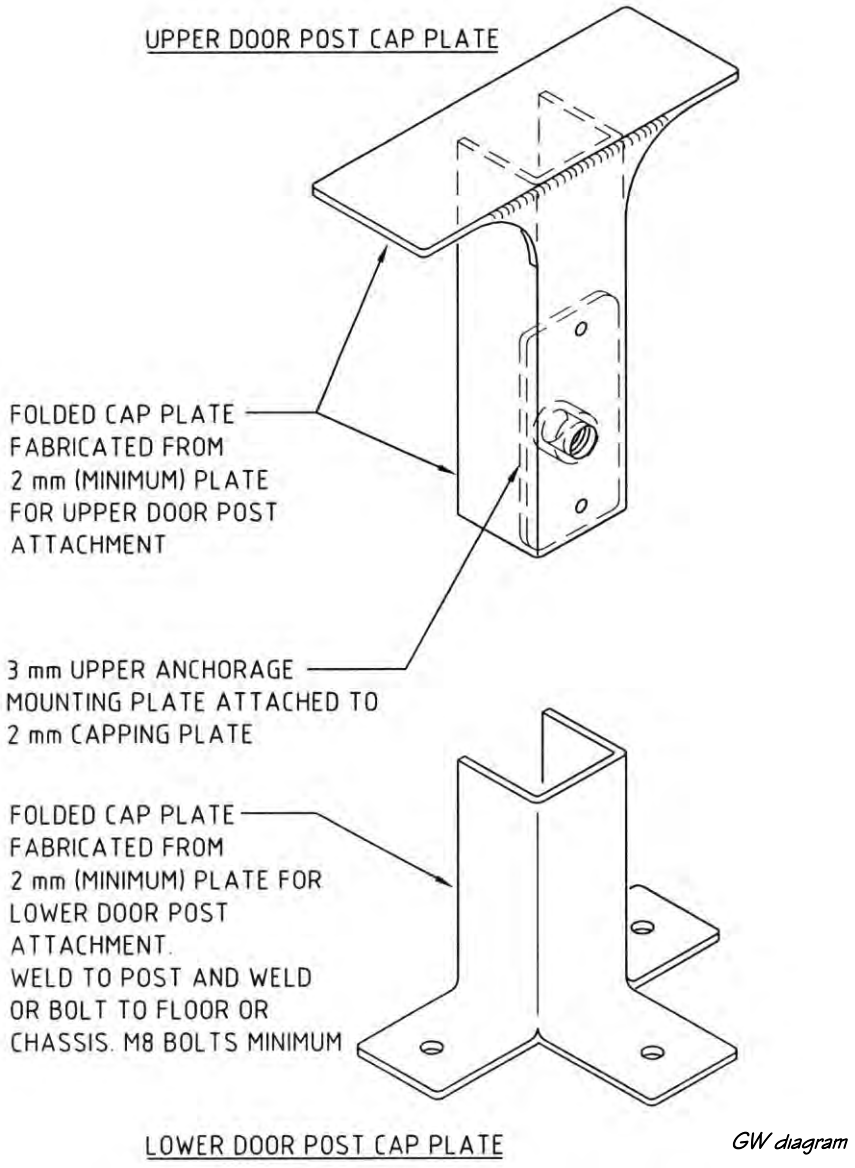


Diagram 14.28 Capping plate design

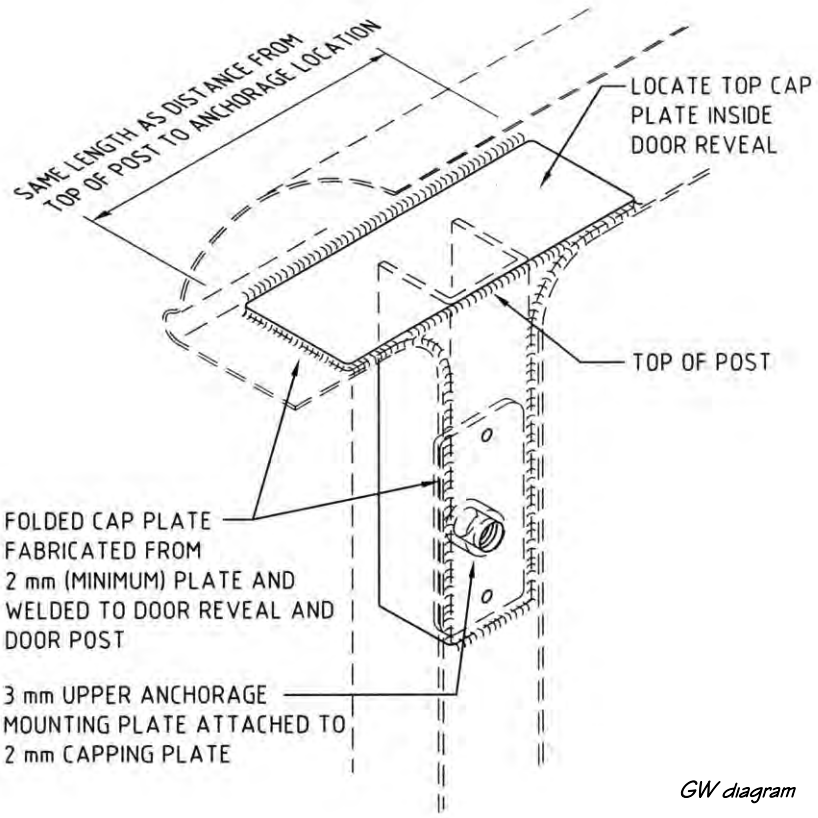


Diagram 14.29 Capping plate attachment into steel body

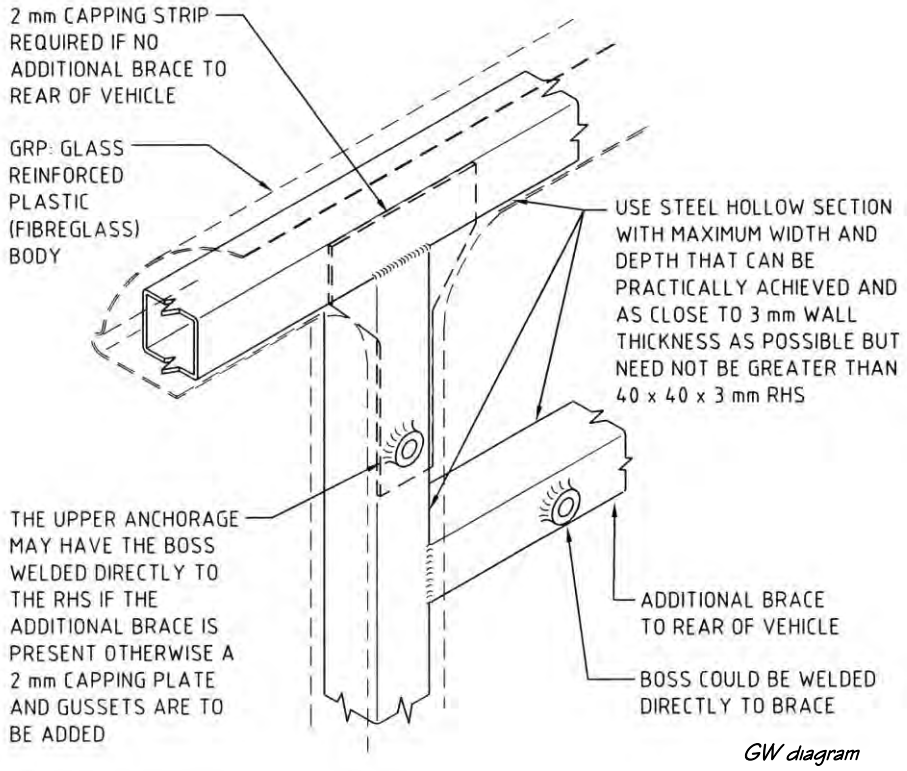


Diagram 14.30 Capping plate attachment into fibreglass body

Reinforcing old and old-style bodies with steel framing

The basic rule of thumb with installing steel framing into any body, whether steel or fibre-glass, is to use the largest material possible (both width and depth) within the available apertures, with a wall thickness as close to 3.0 mm (1/8") as practicable. Having said that, there would never be any need to use a material section in any kind of hobby car body any larger than 40 x 40 x 3 mm (1 ¾ x 1 ¾ x 1/8") RHS.

You will see that in Diagrams 14.31 and 14.32, there are notes which refer to both fibre-glass and steel body reinforcement, however, their actual needs are quite different. Generally speaking, steel bodies just need some sort of reinforcement to ensure that the pillars become sufficiently strong to withstand seatbelt anchorage loadings, whereas fiberglass bodies need full RHS reinforcement to provide stiffness, general strength, and roll-over integrity.

Steel framing for steel-bodied cars

Steel bodies obviously start off with a steel door pillar. The main concern with steel bodies is with reinforcing the top and bottom connections of the B-pillar (and in the case of a 4-door sedan the C-pillar). This is because the OE connections to the roof and the sill are very weak in some early model cars, and we have to ensure that, should the worst happen and major seatbelt anchorage loadings are applied to the pillar, the pillar won't separate from the rest of the body.

All that is required in this case is the 'capping plate' pillar connection reinforcement shown in Diagram 14.28. While you're at it, there are lots of good reasons to reinforce the pillar internally with RHS, but that's certainly not mandatory. If you are going to do this, go for the largest section possible that will fit in the cavity, and keep the wall thickness as close to 3.0 mm (1/8") as practicable.

Steel framing for fibre-glass bodied cars

For fibre-glass bodied cars, steel inner framing will need to be used for a variety of functions, from providing roll-over protection, to hanging doors and supporting the steering column, to supporting upper seatbelt anchorages, so use heavy-wall (as close to 3 mm [1/8"] wall thickness as possible) steel framing. The material should be as large a section as will fit within the recesses of the body, generally as close to 38 x 38 mm (1 ½ x 1 ½") section as can be fitted, particularly above door reveals, and in A, B, and C-pillars. This framing should be fully welded, and bolted to the chassis.

Reinforcing B-pillars on fibre-glass bodied cars is generally not a problem, mainly because there are no (to our knowledge) 4-door fibre-glass bodies on the market. With 2-door bodies such as coupes, roadsters, and even tudors, even if there isn't enough room in the pillar aperture to install a good sized section of RHS, there's always plenty of space to the rear of the B-pillar to enable the builder to get some rearward bracing in to support it. It's also important to run a beam across the roof between the B-pillars and linking up to the B-pillar reinforcement, to help provide resistance to inward loading for the upper seatbelt anchorages, and to provide roll-over protection.

To give builders an idea of material sizes that should be used, here's a couple of examples of materials used in professionally-manufactured bodies that come fully 'steeled-out'.

A New Zealand-built fibre-glass 1934 3 window coupe incorporates in the A-pillars 20 x 20 x 3 mm (25/32 x 25/32 x 1/8") RHS at the top part of the pillar, then enlarging up to 38 x 38 x 3 mm (1 ½ x 1 ½ x 1/8") in the part of the pillar below the window line; in the B-pillars 38 x 38 x 3 mm (1 ½ x 1 ½ x 1/8"); and in the cant rails 38 x 38 x 3 mm (1 ½ x 1 ½ x 1/8"). The transverse floor strength relies on the chassis. This system is considered ideal and should be used as a guideline.

The 'Deuce Customs' fibre-glass1934 3 window coupe, as supplied in New Zealand by Tauranga's Rods by Reid is quite light by comparison, however the framing in these bodies has been designed and tested to meet the Australian Design Rules. It incorporates in the A-pillars 25 x 25 x 2.5 mm (1 x 1 3/32") RHS; in the B-pillars 50 x 20 x 2.5 (2 x 2 x 3/32") RHS; and in the cant rails 19 x 19 x 1.6 (3/4 x ¾ x1/16") RHS. The A and B-pillars are welded to a 50 x 20 x 3 (2 x 2 x 1/8") RHS sill which runs from the firewall frame back to the rear wheel arches. The floor pan incorporates a lot of steel tube ranging from 25 x 25 x 1.6 (1 x 1 x 1/16") through to 35 x 19 x 1.6 (1 3/8 x ¾ x 1/16"), made up of transverse floor members with inner longitudinal members welded to these tranverse members.

Without the luxury of full design and testing, a builder should use the biggest materials that he can physically fit within the cavities.

Use Diagrams 14.31 and 14.32 as a guide to help you design your steel framing, which can be used in both fibre-glass and steel-bodied cars.

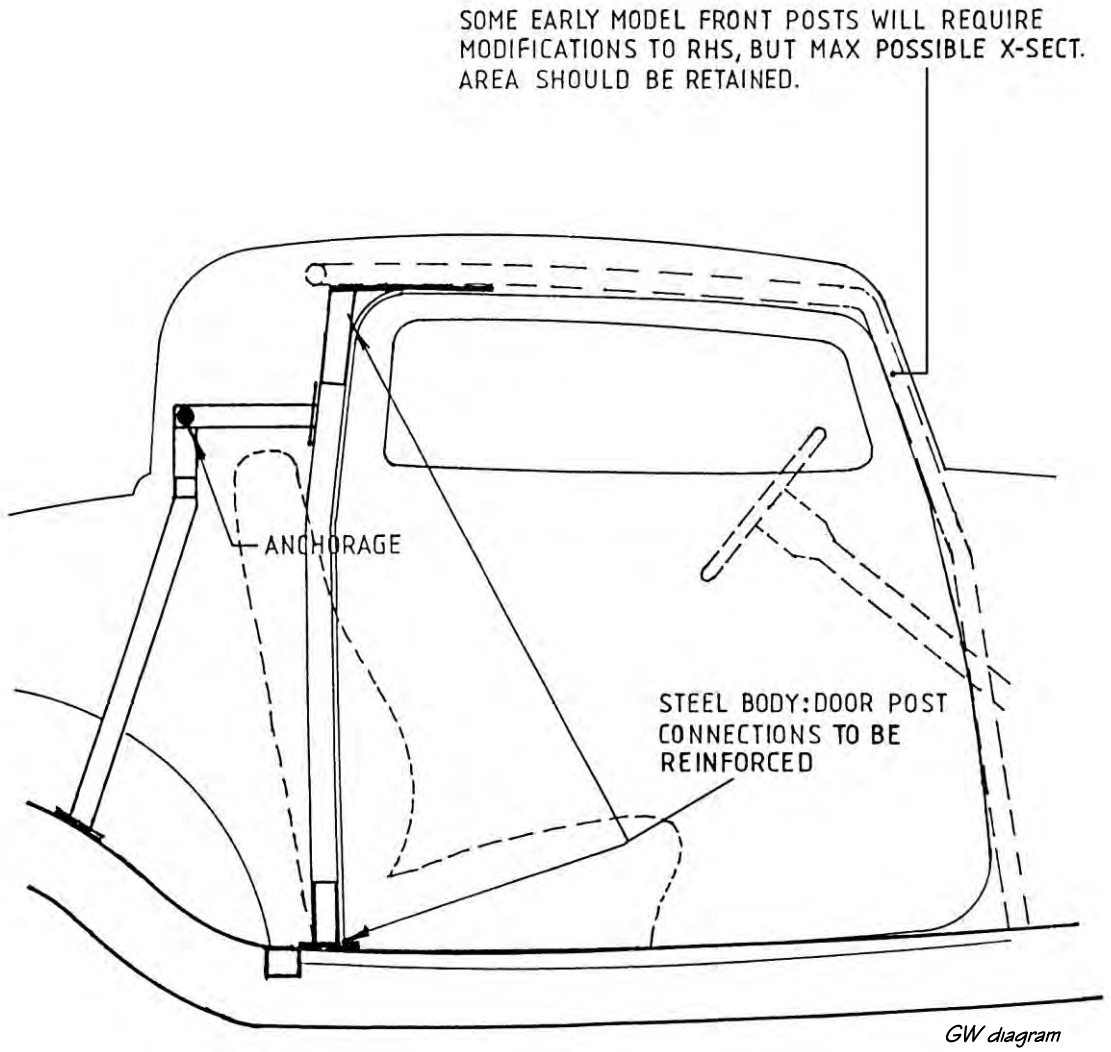


Diagram 14.31 Steel framing in coupe body

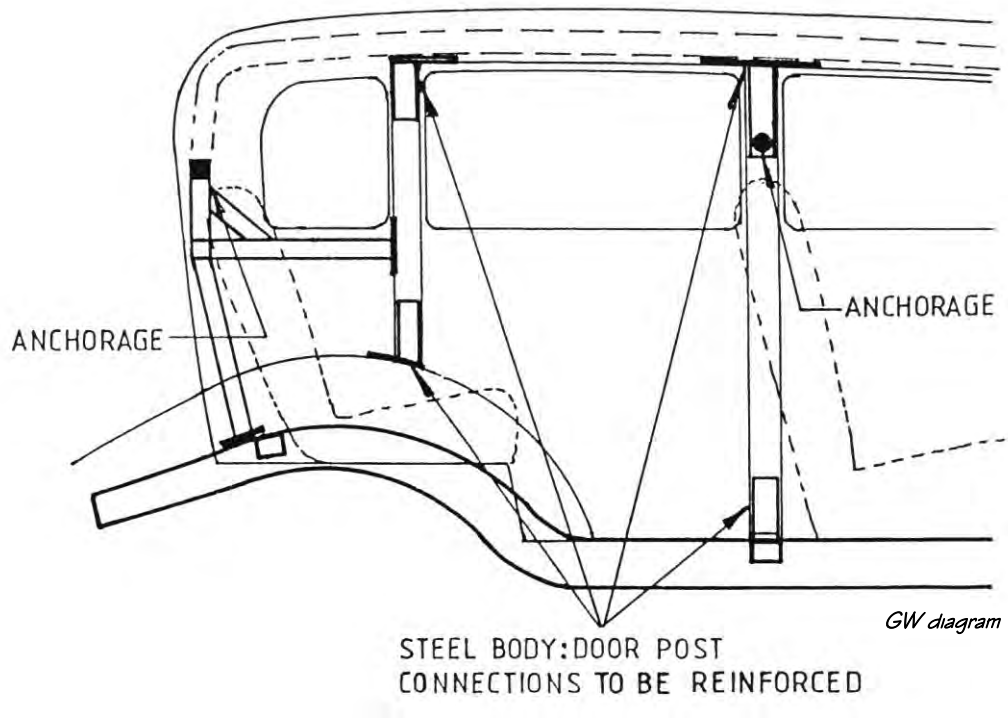


Diagram 14.32 Steel framing in sedan body

Seatbelts in open scratch-built cars

In the past, open vehicles, or to be more precise vehicles with no permanent structure beyond a point 500 mm (20") upward from the intersection of the seat base and the seat back (in other words, no fixed structural roof), didn't have to be fitted with lap and diagonal seatbelts. When the new LVV Standard for Seatbelt Anchorages was developed a few years ago, it was agreed that in the case of a new scratch-built vehicle built after 2003, lap and diagonal seatbelts must be fitted for each front outboard seating position. This sometimes necessitates building in some framing to take the upper anchorages, but within the context of building a car from scratch, it's not a big deal.

Upper seatbelt anchorages in old steel bodies

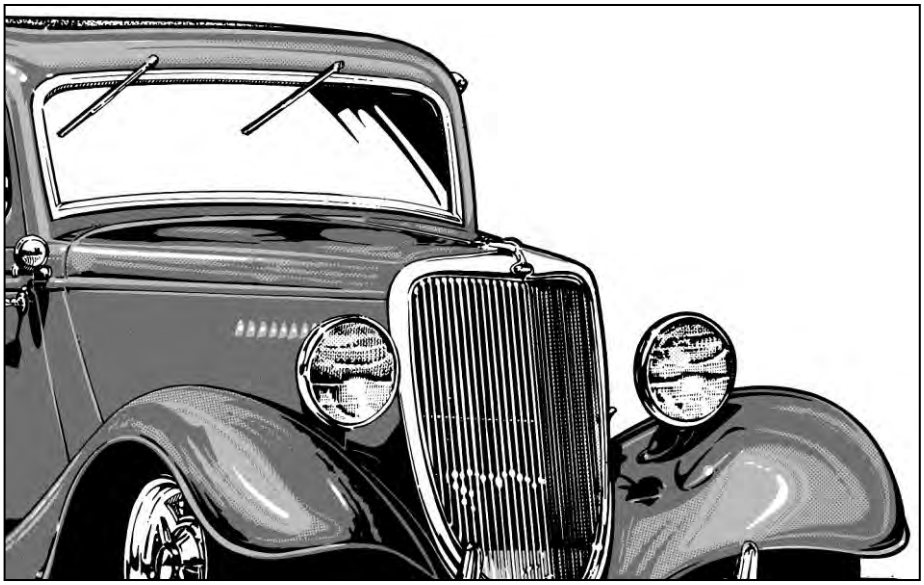
For upper seatbelt anchorages in 1940s and earlier coupes and roadsters, and 1950s and earlier pick-ups, there will usually be some factory structure around the (inside of the) back of the body, close to the area into which the upper anchorages need to go. This structure provides extra strength for the rear and rear side window framing, and can usually provide a base structure from which to add upper anchorages. Roadsters will need new framing built in around the belt-line area.

Get the right help with designing seatbelt anchorages

Because of the high loadings that a seatbelt anchorage might have to withstand, and the importance of it doing its job well if required, it would be well worthwhile getting advice at an early stage from an LVV Certifier who has lots of hands-on experience in both building and LVV certifying scratch-built vehicles. Make it a key discussion point at your chassis inspection.

Chapter 15:

GLAZING & VISION



TJ illustration

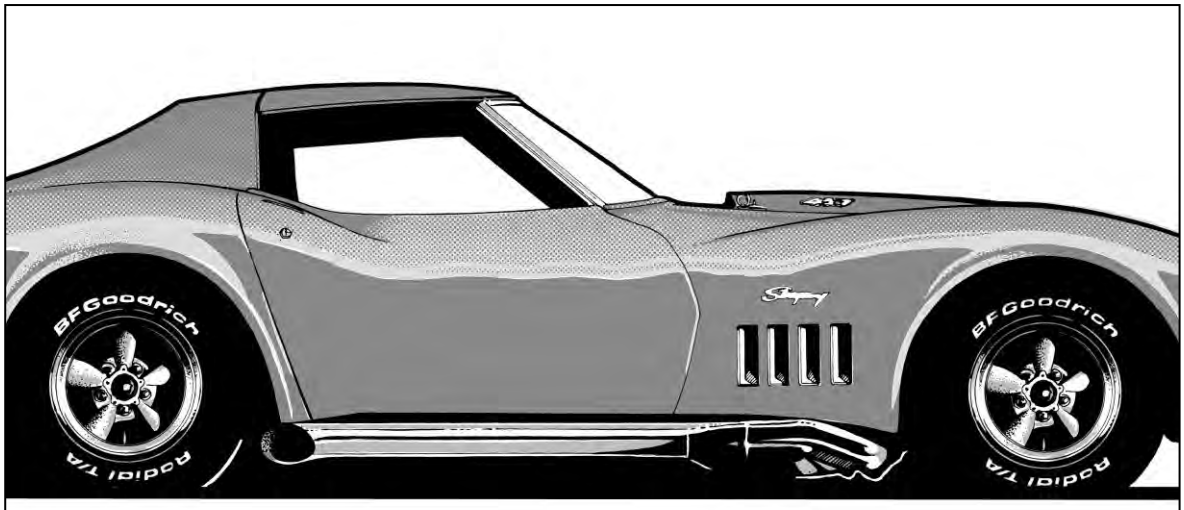
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Key: (for full key details, refer to 'Chapter 2 – About this Manual')

Normal type: Provisions of the NZ Car Construction Manual for all vehicles
Normal type in shaded box: Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates
Italic type: *Extracts from any relevant LVVTA Low Volume Vehicle Standards*
Script type: Helpful hints, tips, explanations, clarifications, and interpretations
Shaded text & dotted vertical stroke in margin: Latest amendments since previous version



TJ illustration

CHAPTER 15: GLAZING & VISION

Introduction:

Having good vision whilst driving a low volume vehicle is achieved by the right attention to a combination of systems; primarily, the kind of glazing used, and the positioning of rear view mirrors. Additionally, the driver's vision can be further influenced by the presence of engine hood protrusions, and during wet weather conditions, the quality of the windscreen washing and wiping system. With the right attention paid to these areas, your chances of saving your pride and joy from errant gates, posts, and other objects capable of damaging that $5000-plus paint-job are maximised. The correct glazing will also minimise the likelihood of serious injury if someone was to come into contact with it during an impact.

Note that where original or authentic reproduction parts are fitted to a production vehicle, the requirements in this chapter do not apply.

Glazing requirements

15.1 General glazing requirements

15.1.1

Glazing fitted to a low volume vehicle must:

(a) be structurally strong and in good condition; and

(b) securely attached to the vehicle; and

(c) have no damage, cracks or chips in any glazing beyond that specified in Section 5-1 of the New Zealand Transport Agency Vehicle Inspection Requirements Manual (VIRM); and

15.1.1(c)

Any LVV Certifier or WoF issuer can provide the details specified for glazing damage in the NZTA VIRM.

(d) have no bubbling in an overlay that could impair the driver's vision in any direction; and

(e) not have, either as the type of glass or as an overlay, any mirroring effect.

15.1.2

A laminated windscreen fitted to a low volume vehicle must not show any signs of discoloration.

15.1.3

15.1.3

Any LVV Certifier or WoF issuer can provide the details specified for glazing modifications in the NZTA VIRM.

Glazing fitted to a low volume vehicle must not have any modification made to, or incorporated within the glazing, including overlays, decals, stone-guards, demisters, antennas, or heaters, other than that specified in Section 5-1 of the New Zealand Transport Agency Vehicle Inspection Requirements Manual (VIRM).

15.1.4

15.1.4

See the 'Useful Information' section for more visible light transmittance details.

The overall visible light transmittance of any glazing fitted to a low volume vehicle must not be less than:

(a) in the case of a windscreen, 70%; and

(b) in the case of side and rear glazing, 35%.

15.2 Windscreens

15.2.1

15.2.1

If a windscreen is made after 1991, the glazing used must be only that specified in 15.2.2, irrespective of the age of the vehicle.

A windscreen, other than one specified in 15.7, fitted to a low volume vehicle manufactured before 1 July 1986 must be made from either:

(a) toughened automotive safety glass that meets either:

(i) an approved trade name listed in Table 15.1; or

(ii) an approved standard specified in 15.5;

or

(b) laminated automotive safety glass that meets either:

(i) an approved trade name listed in Table 15.1; or

(ii) an approved standard specified in 15.5.

15.2.2

A windscreen, other than one specified in 15.7, fitted to a low volume vehicle manufactured on or after 1 July 1986 must be made from laminated automotive safety glass that meets an approved standard specified in 15.5.

15.3 Side and rear windows

15.3.1

Side and rear glazing, other than that specified in 15.7, fitted to a low volume vehicle manufactured before 1 January 1991 must be made from either:

(a) toughened automotive safety glass that meets either:

(i) an approved trade name listed in Table 15.1; or

(ii) an approved standard specified in 15.5;

or

(b) laminated automotive safety glass that meets either:

(i) an approved trade name listed in Table 15.1; or

(ii) an approved standard specified in 15.5.

15.3.2

Side glazing, other than that specified in 15.7, fitted to a low volume vehicle manufactured after 1 January 1991 must be made from either:

(a) toughened automotive safety glass that meets an approved standard specified in 15.5; or

(b) laminated automotive safety glass that meets an approved standard specified in 15.5.

15.3.1

If a windscreen is made after 1991, the glazing used must be only that specified in 15.3.1(b), irrespective of the age of the vehicle.

15.4 Approved trade names for glazing

15.4.1

Approved trade names for a windscreen, side window, or rear window fitted to a low volume vehicle are as specified in Table 15.1.

▪ Armourfloat	▪ HMC Glass Safety Hankuk TV5	▪ Sunmat
▪ Armourplate	▪ Indestructo	▪ Suntex Safety Glass
▪ Blindex	▪ Nippon Safety	▪ Temperlite
▪ Duolite Safety	▪ NM Laminated Safety Glass FHP	▪ Temperlite Santa Marina
▪ Duplate Safety	▪ Peerless	▪ Thorex Connex
▪ Flolite	▪ Plexite	▪ Triplex
▪ Ford Indestructo	▪ Safetyflex	▪ Triplex Plate
▪ Ford Safety Glass	▪ Safety MGB (Meloplate)	▪ Tuflite
▪ Ford Silver Arrow	▪ Safety MGB (Melite Safety Plate)	▪ Tyneside
▪ Glacetex	▪ Sekurit	▪ Veracetex
▪ Hankuk Glass Safety Heat Line	▪ Sigla	
▪ HMC Glass Safety Hankuk TF5	▪ Spectrofloat Splintex	

Table 15.1 Approved trade names for glazing

15.5 Approved standards for glazing

15.5.1

Approved standards with which a windscreen, side window, or rear window, other than one specified in 15.7, fitted to a low volume vehicle must meet are:

(a) UN/ECE Regulation No. 43, Uniform provisions concerning the approval of safety glazing and glazing materials; and

(b) Council Directive of 31 March 1992 on safety glazing and glazing materials on motor vehicles and their trailers; and

(c) British Standard 857:1967, Specification for safety glass for land transport; and

(d) British Standard 5282:1975, Specification for road vehicle safety glass; and

(e) British Standard AU 178a: 1992, Specification for road vehicle safety glass; and

(f) Federal Motor Vehicle Safety Standard No. 205, Glazing Materials; and

15.5.1

When looking to determine if a piece of glazing meets an approved standard, look for the markings shown in Diagrams 15.2 or 15.3. These markings verify that the glazing complies with one or more of the approved standards specified in 15.5.1.

Table 15.2 enables the codes incorporated within approved standards markings to be identified.

(g) American National Standard for Safety Glazing Materials for Glazing Motor Vehicles and Motor Vehicle Equipment Operating on Land Highways – Safety Code; and

(h) Technical Standard for Window glass, Jisha Circular No. 899 of October 1 1983; and

(i) Japanese Industrial Standard R 3211-1992, Safety glass for road vehicles; and

(j) New Zealand Standard 5443:1987, Safety glass for land vehicles; and

(k) Australian Standard 2080-1987, Safety glass for land vehicles; and

(l) Australian/New Zealand Standard 2080:1995, Safety glass for land vehicles; and

(m) Australian Design Rule 8/00, Safety Glazing Material; and

(n) South African Standard SABS 1191/1193-1978, Standard specifications for safety glass for vehicles; and

(o) Allgemeine Bauartgenehmigung (ABG), issued by the German Kraftfahrt-Bundesamt for glazing directly behind, or to the left or right of the rear of, the driver's seatback in its rearmost and upright position that is marked in accordance with the ABG.

15.5.1

The approved standards specified in 15.5.1 for glazing are copied from the Land Transport Rule – Glazing, Windscreen Wipe and Wash, and Mirrors 1999, reproduced here in the interest of convenience.

Diagrams 15.1, 15.2, and 15.3, and Tables 15.1 and 15.2 are copied from the Land Transport New Zealand Vehicle Inspection Requirements Manual (In-service Certification), and reproduced here in the interest of convenience.

15.6 Identification of approved standards for glazing

15.6.1

A windscreen, side window, or rear window fitted to a low volume vehicle, that is required to meet an approved trade name specified in 15.4.1, or approved standard specified in 15.5.1, must be marked to show compliance with an approved standard, by either:

(a) in the case of glazing fitted before 1 January 1997, either:

(i) an adhesive sticker affixed to the glazing that features information as shown in part (a) of Diagram 15.1; or

(ii) permanently etched markings to the glazing that features information as shown in part (b) of Diagram 15.1;

or

15.6.1(a)

Diagram 15.1 shows the format and the type of information that should be permanently etched into a piece of glazing.

(b) in the case of glazing fitted after 1 January 1997, permanently etched markings that contains wording, characters, or symbols, as shown in part (b) of Diagram 15.1, that specify:

(i) the approved standard with which the glazing complies; and

(ii) the type of glazing used; and

(iii) the thickness of the glazing in millimetres, or in the case of laminated glass only, the thickness of the interlayer in millimetres; and

(iv) the identity of the vendor or installer of the glazing.

15.6.1(b)

Diagram 15.1 shows the format and the type of information that should be permanently etched into a piece of glazing.

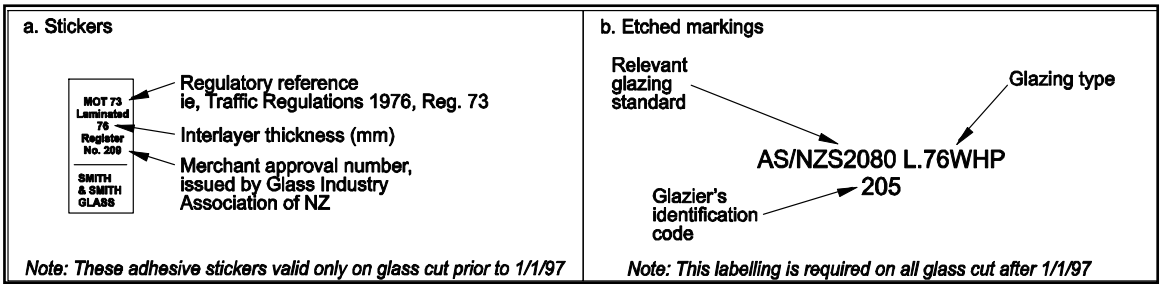


Diagram 15.1 Identification of approved glazing

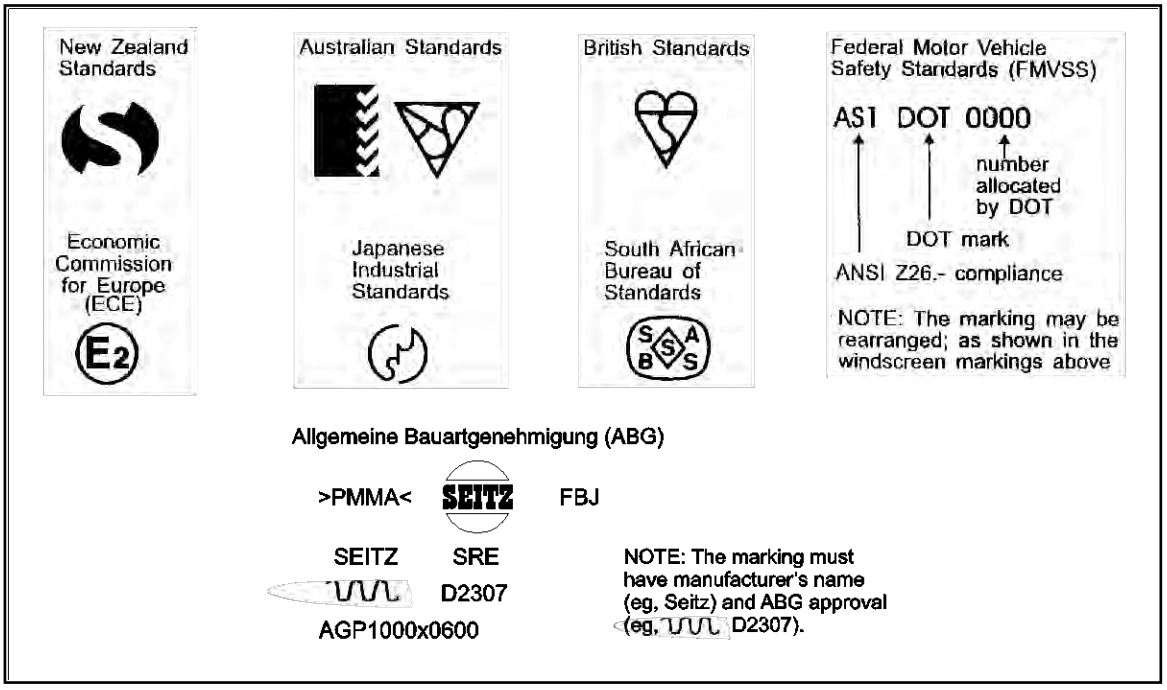


Diagram 15.2 Common approved standards markings

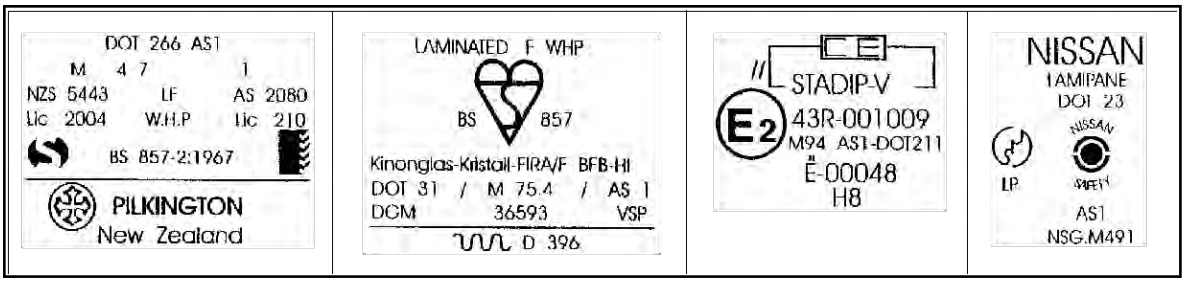


Diagram 15.3 Common laminated windscreen approved standards markings

L =	laminated glass
F =	float glass
P =	plate glass
LF =	laminated float
LP =	laminated plate
/ =	toughened, when near the E2 mark
// or /// =	laminated, when near the E2 mark
TS =	toughened glass
TP =	toughened plate
T =	toughened or tempered
Z =	zone tempered
WHP =	complies with impact test
DOT =	Department of Transport (USA)
A↧S or A↥S =	the glass, in the direction of the arrow, complies with the 70% light transmission requirement
ANSI =	American National Standards Institute
FMVSS codes	
AS1 =	for use anywhere in the vehicle
AS2 =	for use anywhere in the vehicle other than windscreen
AS3 =	for rear and rear side windows only
AS4 and AS5 =	plastic glazing not suitable for driver's vision
Glazing cut from mother sheet	
L.76WHP =	laminated, 0.76 mm interlayer, suitable for all locations
L.38 =	laminated, 0.38 mm interlayer, must not be used for windscreens
PCZ26.1 =	polycarbonate, meets requirements of ANSI Z26, must not be used for windscreens

Table 15.2 Identification of codes for approved laminated glazing

15.7 Alternative rigid plastic glazing materials

15.7.1

Side and rear glazing fitted to a low volume vehicle may be made from a rigid plastic material, provided that each piece of glazing:

(a) meets the technical requirements of item 4, test numbers 2, 10, 13,16,17,19,20,21,and 24 of the ANSI-Z26.1-1983 Standard, and any subsequent amendments; and

(b) is attached to the vehicle in such a way so as to:

(i) be protected against any sliding abrasion that will affect the driver's vision through the glazing; and

(ii) where the glazing is fixed, is able to be forcibly removed in the event of an emergency;

and

(c) is permanently and indelibly marked with the approved LVVTA alternative standard marking.

15.7.2

A scratch-built low volume vehicle that incorporates as part of its design a compound curvature windscreen, may have a windscreen that is manufactured from an alternative rigid plastic material provided that:

(a) no approved automotive toughened or laminated automotive safety glass windscreens are available for the application; and

(b) the glazing material used complies with all test requirements of the ANSI-Z26.1-1983 Standard specified in 15.7.1 except for test 17; and

(c) the glazing material is permanently and indelibly marked with the approved LVVTA alternative standard marking.

15.8 Alternative non-rigid plastic glazing materials

15.8.1

A convertible low volume vehicle that incorporates a folding soft-top roof may have the rear window made from a non-rigid plastic material, provided that the material is transparent.

15.7.1

'Rigid' plastic means a hard or solid plastic, as opposed to a soft fold-up type of plastic, such as that typically used for the rear window of a convertible soft-top.

There are a number of brands of polycarbonate and acrylic material that meet these technical requirements and can be used in side and rear windows. See the 'Useful Information' section at the end of this chapter for more guidance.

Information on the specified markings for rigid glazing can be obtained from LVVTA.

15.7.2

Test 17 is the scratch-resistance test, which cannot be complied with as the scratch-resistant coating applied to the outer side of the material will be damaged during the heating and forming process while making the windscreen.

Information on the specified markings for rigid glazing can be obtained from LVVTA.

15.8

'Non-rigid' plastic means a soft foldable plastic, such as that typically used for the rear window of a convertible soft-top.

15.8.2

A convertible low volume vehicle that incorporates a folding soft-top roof may have the side windows made from a non-rigid plastic material, provided that:

(a) the material is transparent and provides clear vision to the driver in all directions; and

(b) windows can be easily opened or detached in the event of an emergency.

15.8.2

The material must be made of a clear plastic material such as that normally used for a rear window in a folding convertible soft-top.

15.9 Wind deflectors

15.9.1

A wind deflector that is fitted to a low volume vehicle instead of a windscreen must be made from either:

(a) toughened automotive safety glass that meets an approved standard specified in 15.5, and that meets the identification requirements specified in 15.6; or

(b) laminated automotive safety glass that meets an approved standard specified in 15.5, and that meets the identification requirements specified in 15.6; or

(c) a non-shattering transparent rigid plastic polycarbonate material.

15.9.1

A 'wind deflector' (rather than a 'windscreen') is not required to be made of toughened or laminated automotive safety glass, providing it meets the requirement specified in 15.9.1(c).

A 'wind deflector' is defined like this; - if the driver looks <u>through</u> the screen, it's a windscreen; if he looks <u>over</u> it, it's a wind deflector.

Polycarbonate is more suited than acrylic, as polycarbonate will not break and leave a hard edge.

15.10 Wind wings

15.10.1

A soft-top convertible low volume vehicle may be fitted with wind wings provided that the wind wings:

(a) are made from a non-shattering transparent rigid plastic material; and

(b) have all corners and edges rounded and radiused; and

(c) are mounted outward of the outer edges of the windscreen; and

(d) are not part of the side windows; and

(e) are not required to be detached in the event of an emergency exit.

15.10.1

Wind wings are typically used on early convertible sports cars, and are attached to the outside of the windscreen frames to reduce buffeting in the passenger compartment.

Windscreen wiping & washing requirements

15.11 General windscreen wiping & washing requirements

15.11.2

A windscreen wiping and washing system fitted to a low volume vehicle must:

(a) incorporate components that are of a suitable size, type, and output, so as to ensure reliable operation; and

(b) be securely mounted and in good condition.

15.12 Windscreen wipers

15.12.1

A low volume vehicle that is fitted with a windscreen must be fitted with a windscreen wiping system that:

(a) is electrically operated; and

(b) provides a swept area such that no significant area of the windscreen remains unswept by the wipers, other than for:

(i) the areas at the top of the intersection points of the wipers' swept areas; and

(ii) the areas at the outer-most upper corners of the windscreen;

and

(c) together with the windscreen washers, is capable of maintaining clear visibility through the windscreen during all weather conditions; and

(d) has not less than two speeds, or a variable speed control, that will achieve:

(i) a low speed of not less than 20 cycles per minute; and

(ii) a high speed of not less than 45 cycles per minute; and

(iii) no greater variation between the lowest speed and the highest speed of 15 cycles per minute.

A low volume vehicle that was built or modified before January 1992 is not required to comply with 15.12.1.

15.12.1(b)

Defining the correct swept area is difficult without a lot of complex and time-consuming mathematical calculations. Builders should follow diagram 15.4 as a start, and work on wiper numbers, pivot positioning, and arm length, to achieve the greatest possible swept area.

The problem of achieving a good swept area is extra tricky with a chopped windscreen. Not only is getting a good swept area more difficult on a roof-chopped vehicle, it's also more important, because of the vision area already lost through the chop.

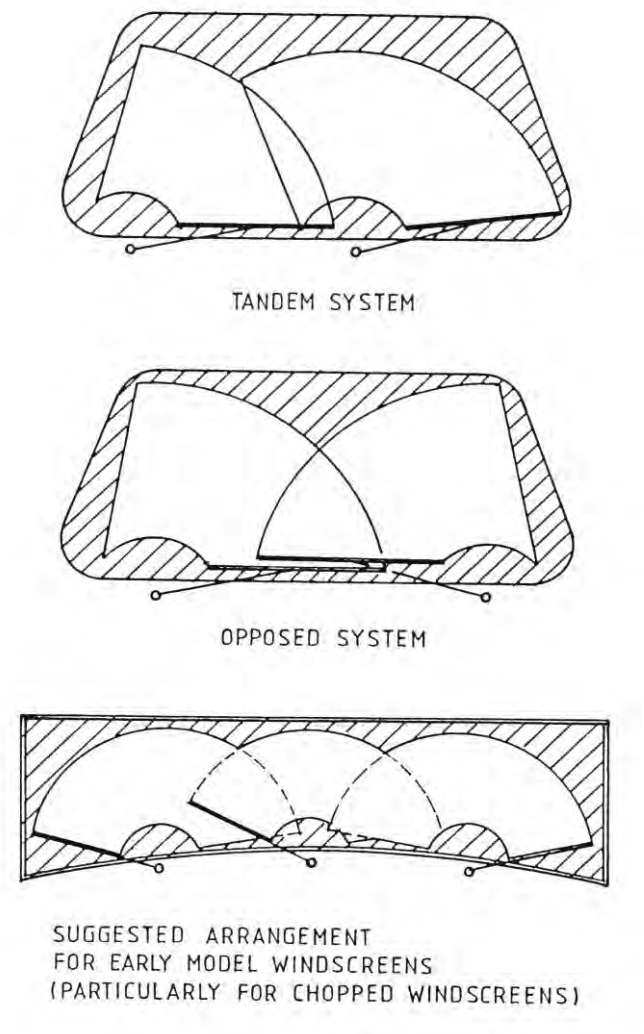


Diagram 15.4 Windscreen wiper swept area

Diagram 15.4

One of the most important areas in which to achieve a good 'sweep', is at the driver's-side A-pillar. Note that the 'Tandem System' diagram shows a full sweep up to, and parallel to, the A-pillar on the left-hand side. This diagram is viewed from outside the vehicle, so that in a right-hand drive vehicle, the driver gets the best possible swept area in the A-pillar region.

15.13 Windscreen washers

15.13.1

A low volume vehicle that is fitted with a windscreen must be fitted with a windscreen washer system that:

(a) is electrically operated; and

(b) incorporates a water reservoir that has a capacity of not less than one litre; and

(c) is capable of directing water onto the exterior of the windscreen within each area swept by a wiper, so that when the windscreen wiping system is operated, water will be dispersed to the whole area swept by the wipers; and

15.13.1

This requirement only applies to scratch-built low volume vehicles, and modified production low volume vehicles where the windscreen wiping system has been modified.

(d) together with the windscreen wipers, is capable of maintaining clear visibility through the windscreen during all weather conditions.

A low volume vehicle that was built or modified before January 1992 is not required to comply with 15.13.1.

Forward vision requirements:

15.14 General forward vision requirements

15.14

Note that a windscreen demisting system is not mandatory. The TAC highly recommends incorporating a demisting system during a scratch-build, however this is not a requirement.

15.14.1

A windscreen fitted to a low volume vehicle that has a fixed roof must have a minimum height of clear visibility area, measured on a vertical plane, of not less than 165 mm (6 ½").

15.14.1

The measurement must be made vertically, irrespective of windscreen angle. The measurement is made this way to ensure that the actual visibility area does not reduce below the minimum allowable figure because of a lot of rake on the windscreen.

15.14.2

Low volume vehicles must be designed and constructed so as to provide to the driver a clear view to the front and both sides of the vehicle from the normal driving position, and the following requirements must be complied with:

(a) the front seats must be mounted in such a way so as to provide the driver as far as practicable with the best available view to the front and both sides of the vehicle; and

(b) any roll-bar or roll-cage fitted to the vehicle must not have any bars positioned in such a way so as to restrict the driver's forward and side vision.

15.15 Fixed-roof vehicle forward vision requirements

15.15.1

A low volume vehicle which has a fixed roof must not have any components or fittings forward of the firewall which protrude above a straight line from the centre-point of the windscreen measured both vertically and horizontally to: (see Diagram 15.5)

On vehicles where the bottom edge of the windscreen is curved (as is the case with most early cars), the vertical measurement of 165 mm should be taken at a point half-way between the mid-point of the windscreen and the A-pillar. Measuring at this point is more representative of where the driver gains his or her forward vision from, rather than at the dead centre of the windscreen.

(a) in the case of protrusions 250 mm (10") or less in width, a point at ground level 15 m (49') forward of the front of the vehicle; or

(b) in the case of protrusions between 250 mm (10") and 400 mm (16") in width, a point at ground level 12 m (39') forward of the front of the vehicle; or

(c) in the case of protrusions 400 mm (16") or more in width, a point at ground level 8 m (26') forward of the front of the vehicle.

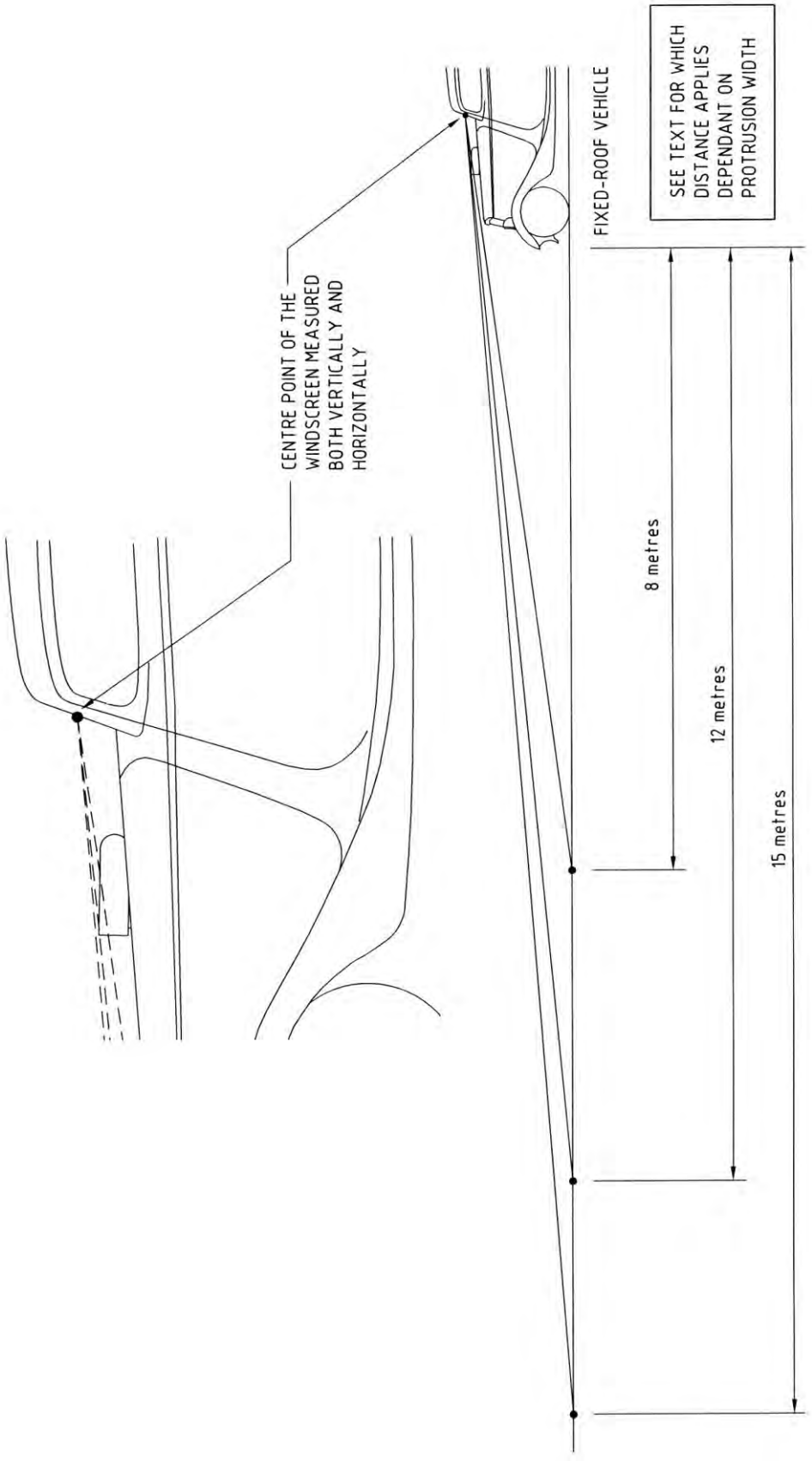


Diagram 15.5 Engine protrusion sight-line (fixed roof vehicles)

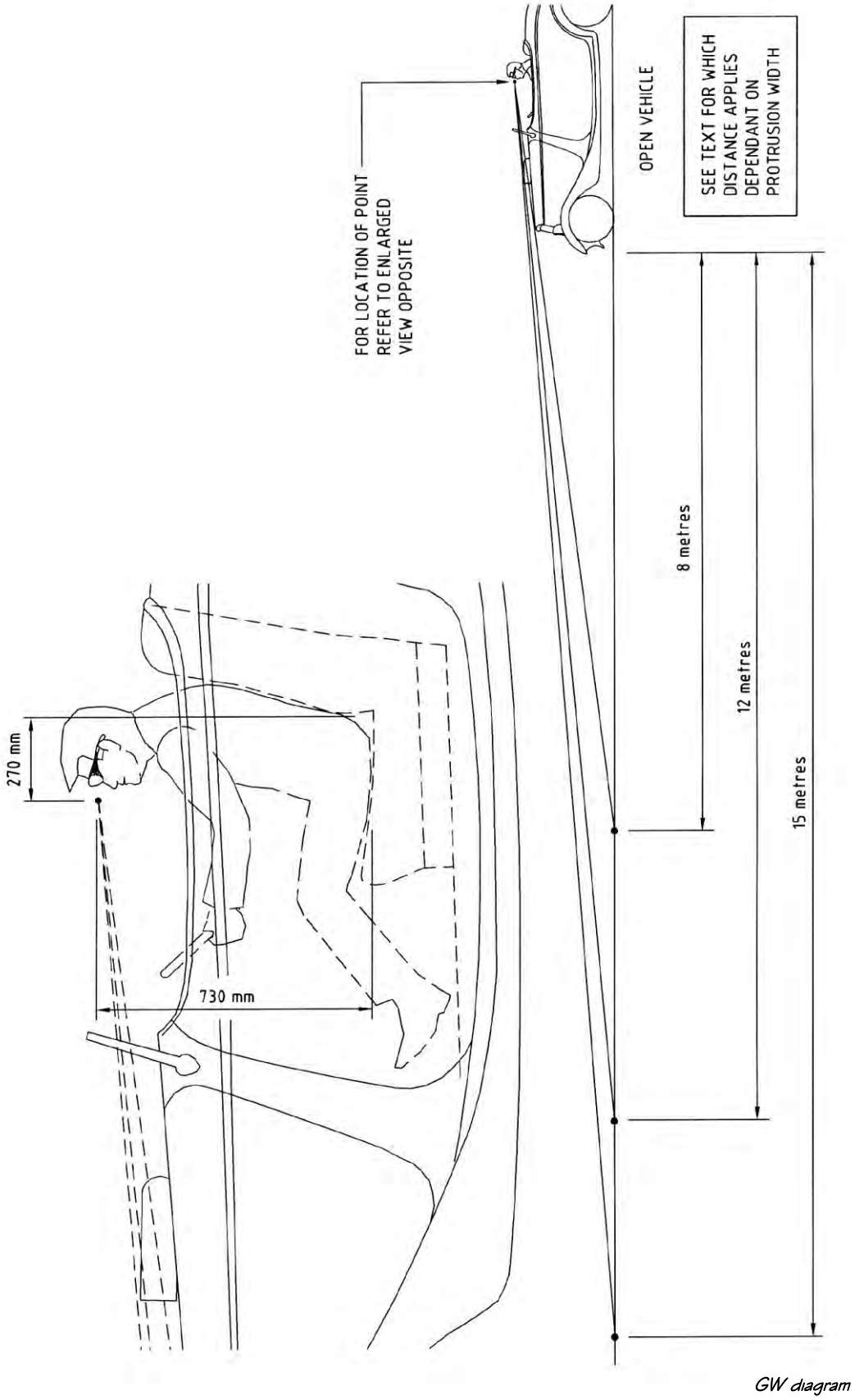


Diagram 15.6 Engine protrusion sight-line (open vehicles)

15.16 Open vehicle forward vision requirements

15.16.1

A low volume vehicle which does not have a fixed roof must not have any components or fittings forward of the firewall which protrude above a straight line measured from a point on the vehicle's longitudinal centre-line 730 mm (28 ¾") above and 270 mm (10 ½") forward of the junction of the uncompressed seat base and back, with the seat in its rear-most and lowest position, to: (see Diagram 15.6)

(a) in the case of protrusions 250 mm (10") or less in width, a point at ground level 15 m (49') forward of the front of the vehicle; or

(b) in the case of protrusions between 250 mm (10") and 400 mm (16") in width, a point at ground level 12 m (39') forward of the front of the vehicle; or

(c) in the case of protrusions 400 mm (16") or more in width, a point at ground level 8 m (26') forward of the front of the vehicle.

Rear vision requirements:

15.17 Rear view mirror requirements

15.17.1

A low volume vehicle must be fitted with:

(a) one interior rear view mirror; and

(b) one exterior rear view mirror on the side of the vehicle nearest the driver; and

(c) in the case of a left-hand drive low volume vehicle, an exterior rear view mirror on the side of the vehicle opposite the driver.

15.17.2

A rear view mirror fitted to a low volume vehicle must be designed and positioned, and be of such dimensions, so as to:

(a) be capable of reflecting to the driver as far as practicable, a clear view of the road to the rear of the vehicle, and of any approaching or overtaking vehicles; and

(b) not unreasonably obstruct the driver's forward vision.

15.17.3

A rear view mirror fitted to a low volume vehicle must:

(a) be able to be adjusted, and maintain its adjusted position; and

(b) be mounted in such a way so as to ensure against the driver's vision through the rear view mirror being obscured by vibration; and

(c) incorporate secure bonding of the glass to the mounting surface.

15.18 Rear view mirrors from production vehicles

15.18.1

A rear view mirror sourced from a production motor vehicle may be fitted to a low volume vehicle, provided that:

(a) *the rear view mirror is unmodified; and*

(b) *the rear view mirror is mounted so as to replicate the location and installation method used by the donor vehicle manufacturer; and*

(c) *the vehicle to which the mirror was originally fitted was manufactured in either:*

(i) *the United States of America on or after 1 January 1976; or*

(ii) *Europe or the United Kingdom on or after 1 January 1971; or*

(iii) *Japan on or after 1 January 1983; or*

(iv) *Australia on or after 1 January 1988.*

A low volume vehicle that was built or modified before January 1992 is not required to comply with 15.18.1.

15.19 Rear view mirrors from other sources

15.19.1

An interior rear view mirror from a source other than that specified in 15.18.1 must:

(a) *have a radius of not less than 3 mm (1/8") on all edges and corners of the mirror and its attachment structure which face toward the passenger compartment of the vehicle; and*

(b) *be designed and attached in such a way as to collapse, break off, bend away, or swing away upon impact, leaving no sharp edges, rigid mounting points or dangerous protrusions facing the occupants in doing so.*

A low volume vehicle that was built or modified before January 1992 is not required to comply with 15.19.1.

15.19.2

An exterior rear view mirror from a source other than that specified in 15.18.1 must have a radius of not less than 3 mm (1/8") on all edges and corners of the mirror and its attachment structure which face toward the front of the vehicle.

A low volume vehicle that was built or modified before January 1992 is not required to comply with 15.19.2.

Exclusions:

15.20 Interior rear view mirror exclusions

15.20.1

A low volume vehicle that is designed in such a way that an interior rear view mirror would not provide to the driver sufficient vision to the rear of the vehicle for safe operation, is not required to comply with 15.17.1(a), provided that the vehicle is fitted with an exterior rear view mirror on each side of the vehicle.

15.20.1

This exclusion would typically apply to a mid-engined vehicle where there is little or no rearward vision behind the driver, due to the presence of the rear bulkhead in front of the engine.

15.21 C-zone mirror positioning exclusions

15.21.1

An interior rear view mirror fitted to a low volume vehicle is not required to comply with 15.19.1, provided that it is positioned within the C-zone, as specified in 16.3 of 'Chapter 16 - Interior Equipment.

15.21.1

This exclusion would typically apply to a sports car that uses a centrally positioned dash-mounted interior rear view mirror.

15.22 Original equipment mirror exclusions

15.22.1

A rear view mirror fitted to a modified production low volume vehicle is not required to meet 15.19 provided that the mirror is either:

(a) *a standard or optional item supplied by the vehicle manufacturer, or an item which is an authentic reproduction of such equipment; or*

(b) *an item which was available as after-market equipment at the time the vehicle was manufactured.*

15.23 Split windscreen wiping swept area exclusions

15.23.1

A low volume vehicle which features a split, or two-piece windscreen, is not required to meet 15.12.1(b), provided that:

(a) the vehicle was manufactured before 1950; and

(b) the swept area provided by the wipers is maximised, and the driver has good forward vision.

Useful information

Visible light transmittance

Visible light transmittance (VLT), in the context of percentages, means the amount of light that can be transmitted through a piece of glass. This is determined by the level of tinting in the glass, or in an overlay. The amount of VLT that a given piece of glass has is pretty much impossible for someone to accurately identify without the correct measuring equipment.

A car builder needs to make sure that the person or company cutting his glass, or supplying tint film, fully understands the requirements specified in 15.2 to 15.6, and then rely on that person's industry knowledge. Obviously, it's important to use a company that knows what they're doing.

Laminated safety glass

Laminated glass consists of two (or more) layers of glass, which have been adhered together with an interlayer of plastic sheet material. In the event of an impact and subsequent damage to the glass, the interlayer keeps the broken glass together rather than individual fragments becoming separated and scattering. Laminated safety glass must be used in all windscreens.

Laminated automotive safety glass has a thickness of 6.76 mm (17/64"); this comprises two 3 mm (1/8") layers of toughened glass, with a 0.76 mm (1/32") interlayer sandwiched and bonded between the two layers of glass.

Note that there is a difference between approved automotive laminated safety glass, and approved architectural laminated safety glass. Despite looking identical, and nowadays even having the same interlayer thickness, architectural glass must never be used in an automotive application.

Toughened safety glass

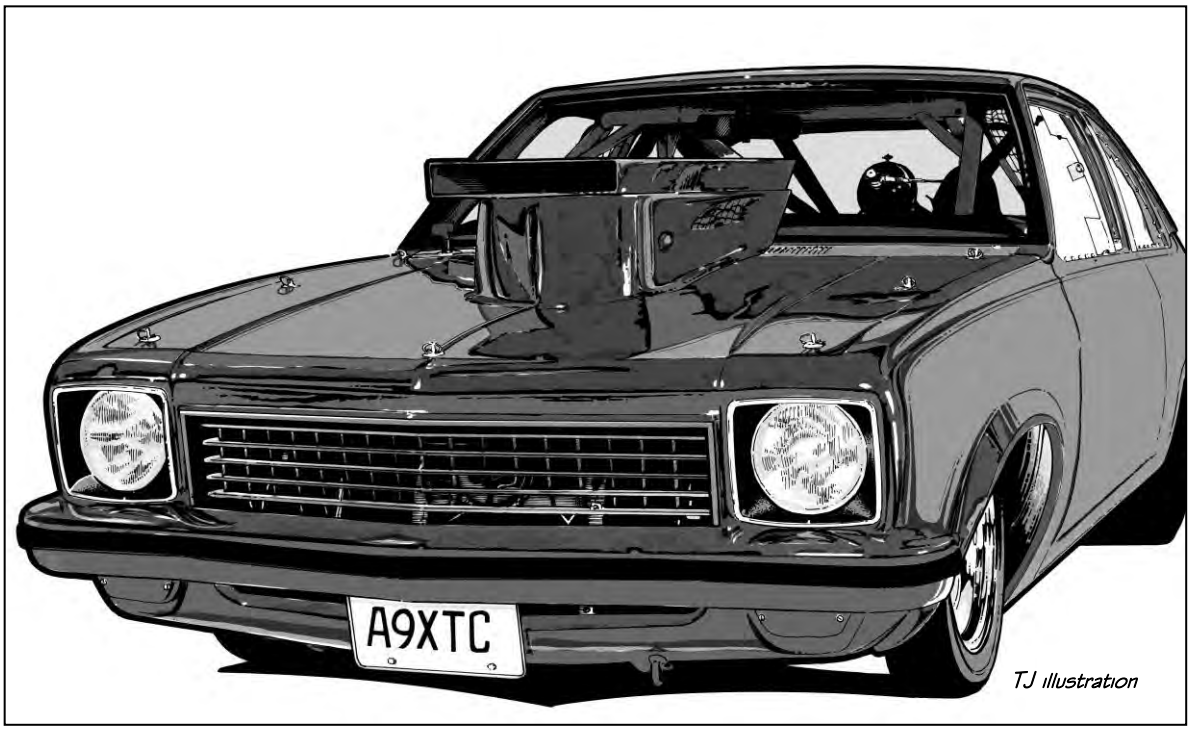
Toughened glass is a single sheet of glass which has been subjected to special processes which creates a tough compression-stressed layer on the glass surface, to increase its strength in the event of an impact, and to ensure that the glass breaks into tiny fragments, rather than large jagged pieces. Toughened glass is only allowed to be used in side and rear windows.

Alternative rigid plastic glazing

There are a number of plastic materials on the market that meet the requirements of 15.7.1 and 15.7.2. These materials include 'Lucite SAR' ('SAR' meaning scratch and abrasion resistant); 'Lexan MR' series ('MR' meaning mar ['mar' meaning scratch] resistant); 'Cyrolon AR' series ('AR' meaning abrasion resistant); and Tuffak CM-2.

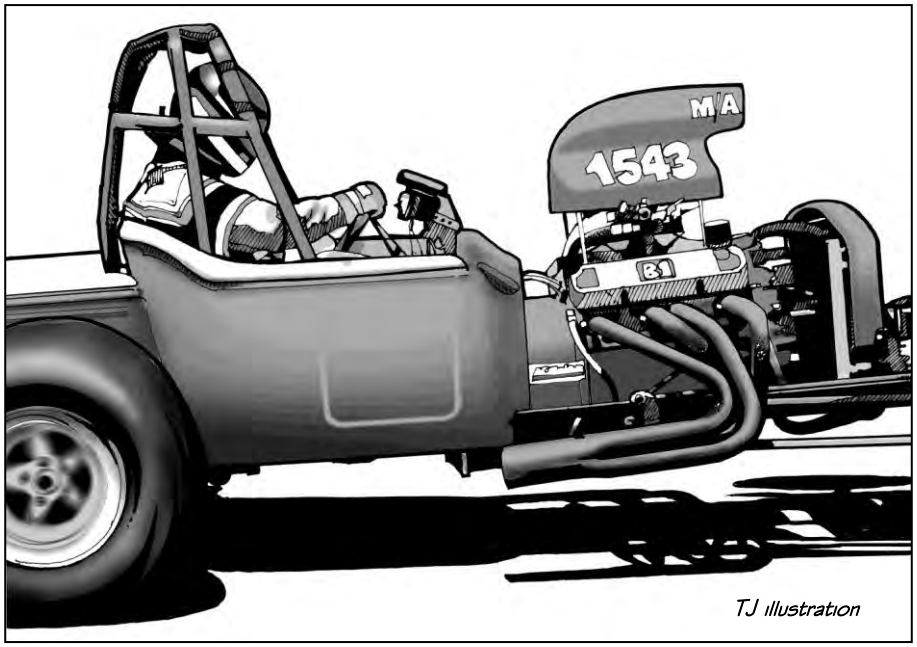
'Lexan', 'Cyrolon', and 'Tuffak' products are all polycarbonates, whereas 'Lucite' is an acrylic.

The best products for automotive use are polycarbonate materials which will bend almost indefinitely, whereas acrylic will only bend a small amount and then break, leaving a sharp edge (less than ideal in a roll-over situation), so check out what the products that you are looking at are made from.



Chapter 16:

INTERIOR EQUIPMENT



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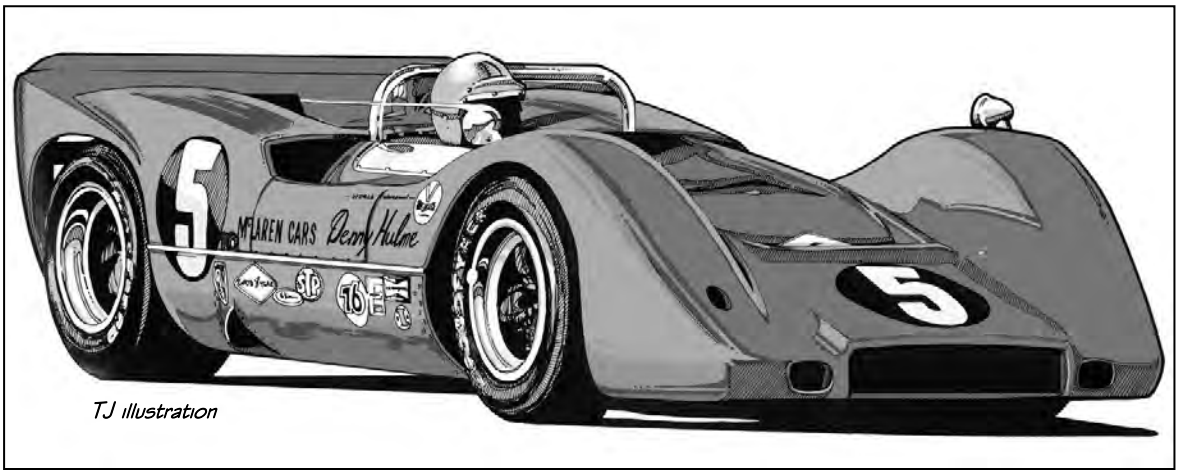
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Key: (for full key details, refer to 'Chapter 2 – About this Manual')
Normal type: Provisions of the NZ Car Construction Manual for all vehicles
Normal type in shaded box: Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates
***Italic type**: Extracts from any relevant LVVTA Low Volume Vehicle Standards*
Script type: Helpful hints, tips, explanations, clarifications, and interpretations
Shaded text & dotted vertical stroke in margin: Latest amendments since previous version



TJ illustration

CHAPTER 16: INTERIOR EQUIPMENT

Introduction:

As well as safety standards aimed at making a motor vehicle less likely to become involved in an accident, such as those for braking, steering, and suspension systems, many safety standards are directly associated with how a vehicle performs in terms of protecting its occupants in the event of an accident. Interior impact performance is one of the most important occupant protection standards there is.

This chapter is aimed at providing simple design features that, if incorporated during the construction of a hobby car, can result in a reduction of the severity of occupants' injuries during contact with the vehicle's interior surfaces, fittings, and controls in the event of an accident.

Note that where a production vehicle retains its original surfaces, fittings, and controls, the requirements in this chapter do not apply.

Defining passenger compartment zones:

16.1 Defining 'A-Zone' areas

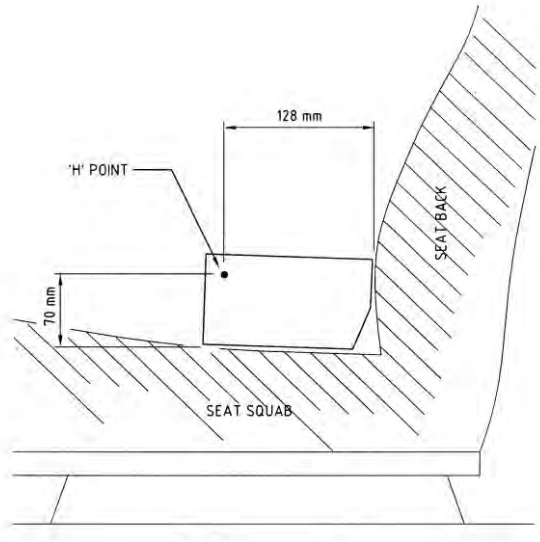
16.1.1

The 'A-Zone' of a low volume vehicle passenger compartment is the area inside:

(a) *an arc swung in a forward direction from the h-point using either a LVVTA H-frame, or a LVVTA H-point Template as shown in Diagram 16.1, with the seat in its mid-point position if adjustable, from the seatback in a normal driving position, to the seat base (see Diagram 16.1), of:*

16.1.1

'Passenger compartment' means the area within the inside of a vehicle, in which the driver and the passengers sit.

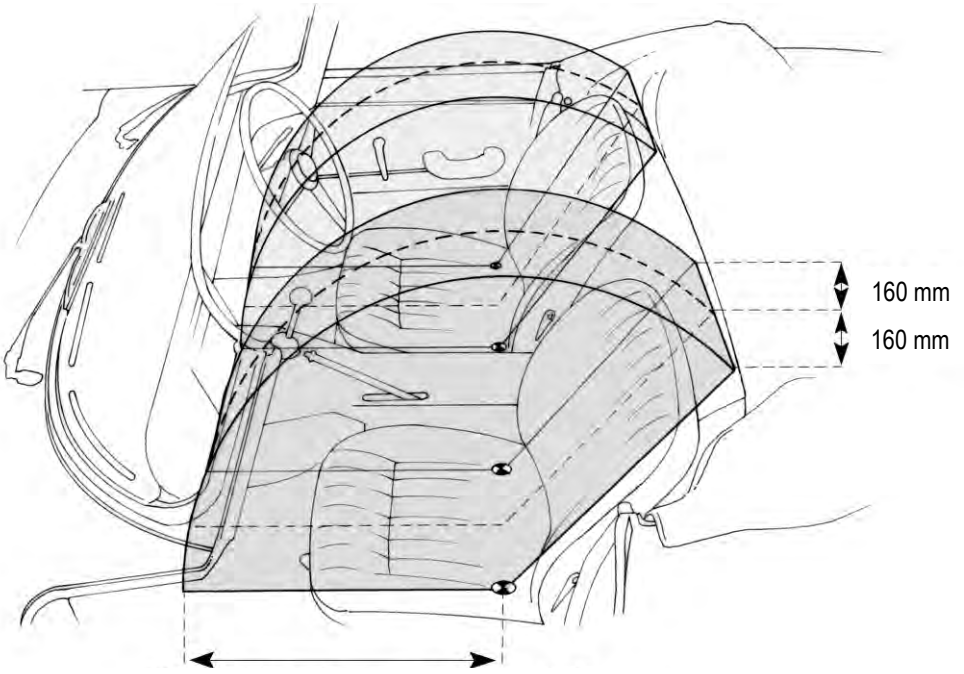


GW diagram

Diagram 16.1 LVVTA H-point template

(i) *where web-clamp retractor lap and diagonal or four-point harness seatbelts are fitted, a 700 mm (28") radius (see Diagram 16.2); or*

(ii) *where seatbelts of types other than those specified in 16.1.1(a)(i) are fitted, a 900 mm radius (37") (see Diagram 16.2); and*



700mm WITH WEB CLAMP RETRACTOR & FULL HARNESS BELTS
900mm WITH OTHER TYPES OF BELTS

'A-ZONE' AREAS ARE SHOWN IN SHADING

TJ diagram

Diagram 16.2 Passenger compartment 'A-zone' areas

(b) *160 mm (6 ½") on either side of the longitudinal centre-line of each seating position (see Diagram 16.2).*

16.2 Defining 'B-Zone' areas

16.2.1

The 'B-Zone' of a low volume vehicle passenger compartment is the remaining area within the passenger compartment surrounding the A-Zone specified in 16.1.1, but does not include the 'C-Zone' of a low volume vehicle passenger compartment specified in 16.3.1.

16.3 Defining 'C-Zone' areas

16.3.1

The 'C-Zone' of a low volume vehicle passenger compartment is:

(a) *the area:*

(i) *below the horizontal plane measured at the lowest point of the front seat cushion (see Diagram 16.3); and*

(ii) *behind, and following a plane extending upward, parallel to the back of the backrest on the rear-most seat (see diagram 16.3); and*

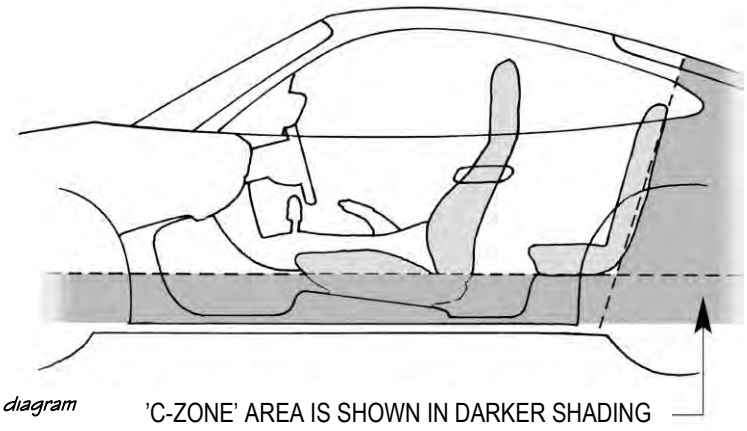


Diagram 16.3 Below and behind seat-line 'C-zone' areas

(b) *provided that no front centre seating position exists, the width of the dashboard and centre console surface area, which may not exceed 140 mm (5 ¾") on either side of the longitudinal centre-line of the vehicle (see Diagram 16.4) and:*

16.1, 16.2, and 16.3

The basic principle behind the three zones is this;

- the 'A-zone ' is where an occupant head-strike is likely to occur in an impact, so safety requirements in this area are critical;
- the 'B-zone' is less critical but never-the-less important as a lot of occupant arm and leg strike could occur in this area in an impact;
- the 'C-zone' is unlikely to be contacted by occupants in the event of an impact, so much less importance is placed on the safety requirements in this area.

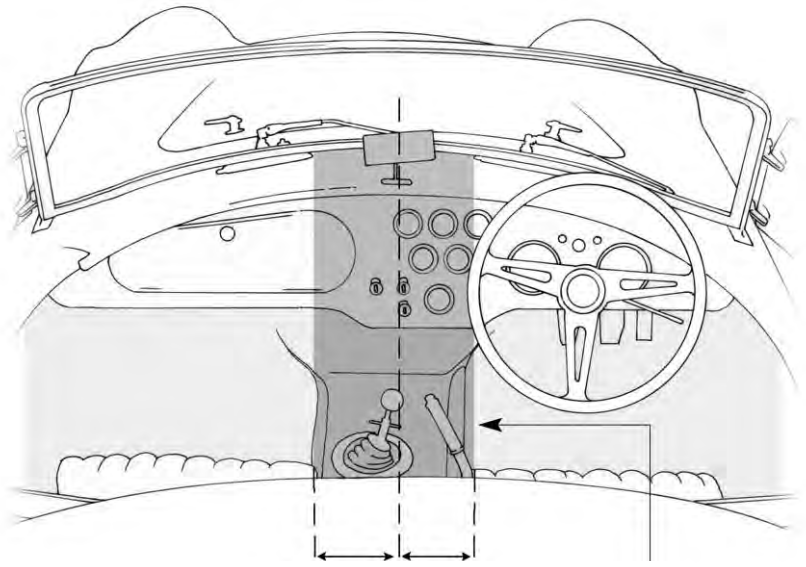


Diagram 16.4 Dashboard and centre console 'C-zone' area

(c) *the area forward of the steering wheel, defined as a forward horizontal projection of an area 400 mm (16") across, circumscribing the upper-most end of the steering column, (see Diagram 16.5); and*

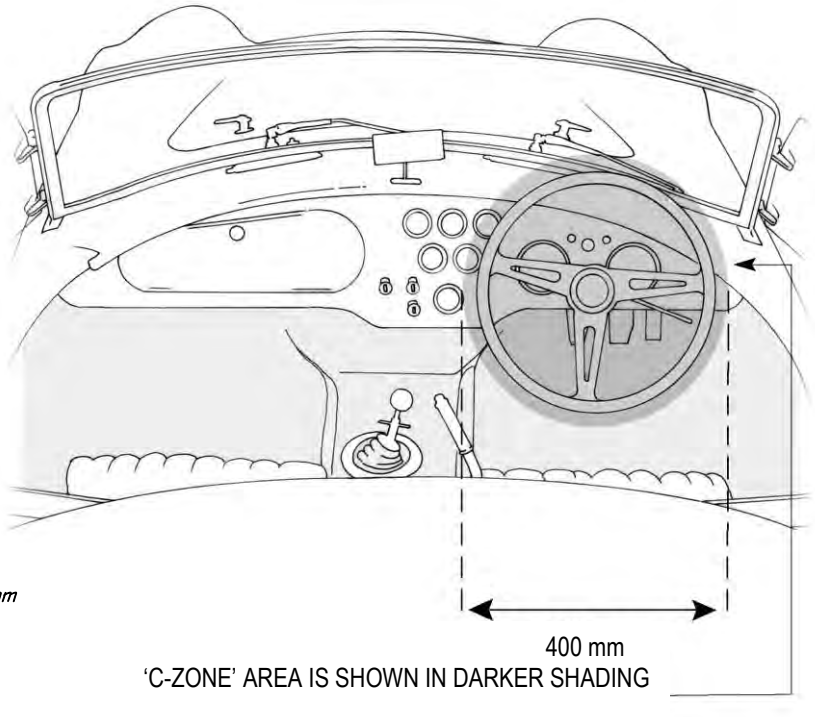


Diagram 16.5 Steering wheel 'C-zone' area

(d) *any part of the dashboard and instrument panel between the edge of the area specified in 16.3.1(c) and the nearest inner pillar or sidewall area (see Diagram 16.6); and*

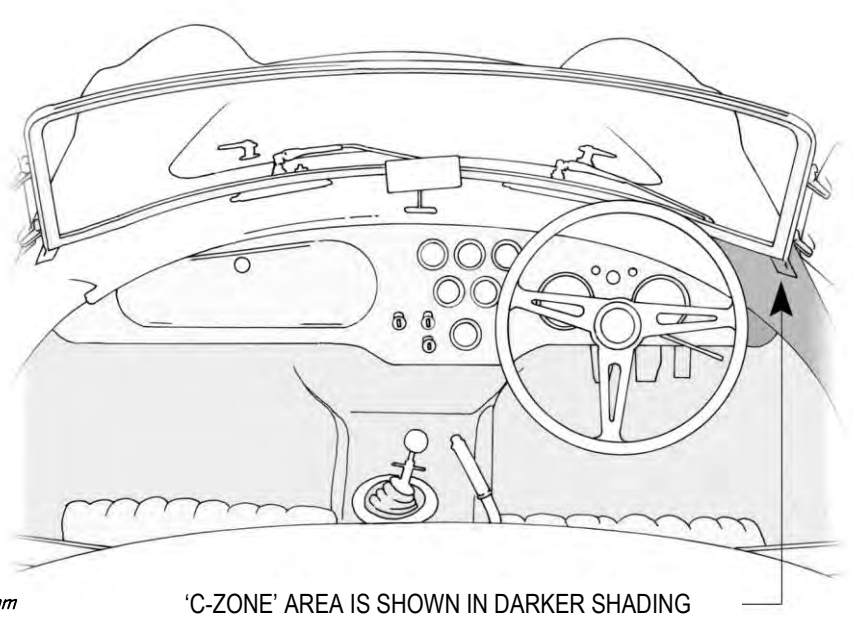


Diagram 16.6 Steering wheel to nearest pillar or sidewall 'C-zone' area

(e) *any window glass or window glass framing; and*

(f) *roof bows and related components within a hood frame of a convertible vehicle; and*

(g) *any area which is unable to be contacted by a 165 mm (6 ¾") diameter head-sphere; and*

(h) *any other areas which could not reasonably be expected to be contacted by an occupant in the event of a front, rear, or side impact, or a roll-over.*

The general intent of this chapter is to ensure that the areas of the passenger compartment that any occupants may contact in the event of an impact or roll-over, do not incorporate any sharp points, edges, or protrusions that could increase the likelihood or degree of injury to those occupants.

'A-zone' interior equipment requirements

16.4 Dashboard surfaces

16.4.1

All surfaces of custom-built dashboard fascias fitted within the 'A-Zone' of a low volume vehicle passenger compartment must be designed and constructed so that any surfaces that face the occupants:

(a) *have all corners and edges with a radius of no less than 5 mm (3/16"); and*

(b) *either:*

(i) *absorb impact energy by collapsing, deforming, or displacing in the event of an impact, leaving no sharp projections in doing so; or*

(ii) are covered in a high-density energy-absorbing material of no less than 10 mm (13/32") thickness.

16.5 Dashboard supporting structures

16.5.1

Any sections of solid structure supporting any custom-built dashboard fascia surfaces within the 'A-Zone' of a low volume vehicle passenger compartment, must, if directly exposed to the passenger compartment:

(a) be provided with a radius on all corners and edges of no less than 5 mm (3/16"); and

(b) be covered in a high-density energy-absorbing material of no less than 10 mm (13/32") thickness.

16.4.1

Any OE dashboard and OE supporting structure is deemed to comply with the requirements of Chapter 16. The intent of this section is to ensure that custom-built dashboards and support structures are not too rigidly constructed.

16.4.1(b)(i)

Typical fibreglass dashboards, or light-gauge aluminium or panel steel dashboards, will meet this requirement.

16.5.2

In addition to 16.5.1, any sections of solid structure that are within the 'A-Zone' of a low volume vehicle passenger compartment, that are supporting any custom-built dashboard fascia surfaces, and are positioned within 50 mm (2") behind any dashboard fascia surfaces that face the passenger compartment, must:

(a) be provided with a radius on all corners and edges of no less than 5 mm (3/16"); and

(b) be covered in a high-density energy-absorbing material of no less than 10 mm (13/32") thickness.

16.5.2

Any rigid and sharp objects (such as an angle-iron dash support) positioned behind the dashboard in the 'A-zone' areas can be a safety hazard in an impact, especially when the dashboard itself is made from a light deformable material. Any rigid and sharp solid structure facing the passenger compartment must be protected as much as possible in case of contact from occupants.

16.6 Steering column and wheel

16.6.1

A steering column and wheel fitted within the 'A-Zone' of a low volume vehicle passenger compartment must meet any applicable requirements specified in 'Chapter 7 - Steering Systems'.

16.7 Switches, knobs, and instruments

16.7.1

All dashboard equipment, including switches, knobs, instruments, accessory equipment, and other fittings and controls positioned within the 'A-Zone' of a low volume vehicle passenger compartment, must be mounted in such a way that upon contact by an occupant in the event of an impact, the equipment will collapse through the panel or surface to which it is attached, leaving no sharp edges in doing so.

16.7.1

Generally, these items are fitted in a 'B-zone' or a 'C-zone'. By keeping all switches and other equipment in the 'C-zone', selection and installation is much easier.

16.7.2

A glove-box compartment door fitted within the 'A-Zone' of a low volume vehicle passenger compartment must incorporate a latching mechanism that minimises the likelihood of the door opening in the event of an impact.

16.8 Seats

16.8.1

Any part of a seat-back positioned within a rear seat 'A-Zone' of a passenger compartment in a low volume vehicle must:

(a) incorporate no exposed rigid frame or fittings, or sharp edges; and

(b) *either:*

(i) *be padded and upholstered; or*

(ii) *have the seat-back manufactured from a smooth deformable material.*

16.8.2

A head restraint fitted to a seat within the 'A-Zone' of a low volume vehicle passenger compartment must meet any applicable requirements specified in 'Chapter 14 - Seats, Seatbelts, & Anchorages'.

16.9 Roll-bars and roll-cages

16.9.1

Unless the vehicle has been issued with a valid and current LVV Authority Card that records 'Competition Occupant Protection System' on the Authority Card, no part of any roll-bar or roll-cage may be positioned within the 'A-Zone' of a passenger compartment in a low volume vehicle.

16.9.1

See 'Useful Information' section for more information on LVV Authority Cards for fenders, roll-cages, and other items.

'B-zone' interior equipment requirements

16.10 Dashboard surfaces

16.10.1

All surfaces of dashboard fascias fitted within the 'B-Zone' of a low volume vehicle passenger compartment must be designed and constructed so that any corners and edges of any surfaces that face the occupants either:

(a) are provided with a radius of no less than 5 mm (3/16"); or

(b) are covered in a high-density energy-absorbing material of no less than 10 mm (13/32") thickness.

16.11 Steering column and wheel

16.11.1

A steering column and wheel fitted within the 'B-Zone' of a low volume vehicle passenger compartment must meet any applicable requirements specified in 'Chapter 7 - Steering Systems'.

16.12 Switches, knobs, and instruments

16.12.1

All dashboard equipment, including switches, knobs, instruments, accessory equipment, and other fittings and controls positioned within the 'B-Zone' of a low volume vehicle passenger compartment, either:

(a) if protruding from the dashboard surface by between 5 mm (3/16") and 10 mm (13/32") from the panel surface, must have a face area of no less than approximately 2 square cm (3/8 square "); or

(b) if protruding from the dashboard surface by 10 mm (13/32") or further from the panel surface, must have a face area of no less than approximately 6 square cm (1 square ").

16.12.2

In addition to 16.12.1, all dashboard equipment, including switches, knobs, instruments, accessory equipment, and other fittings and controls positioned within the 'B-Zone' of a low volume vehicle passenger compartment, must either:

(a) *have all contactable edges and corners provided with a radius of no less than 3 mm (1/8"); or*

(b) *be designed so that in the event of an impact, the items will collapse through the panel surface, or break off or bend, leaving no sharp edges or protrusions facing towards the passenger compartment in doing so.*

16.13 Seats

16.13.1

Any part of a seat-back positioned within a rear seat 'B-Zone' of a passenger compartment in a low volume vehicle must:

(a) incorporate no exposed rigid frame or fittings, or sharp edges; and

(b) either:

(i) be padded and upholstered; or

(ii) have the seat-back manufactured from a smooth deformable material.

16.14 Roll-bars and roll-cages

16.14.1

A roll-bar may be positioned within the 'B-Zone' of a low volume vehicle passenger compartment, providing that the requirements of 16.14.3 are met.

16.14.2

A roll-cage may be positioned within the 'B-Zone' of a low volume vehicle passenger compartment, provided that:

(a) *the vehicle is not a modified production Class MA, with unitary body construction, with a permanent roof structure; and*

(b) *the requirements of 16.14.3 are met.*

16.14.3

A low volume vehicle fitted with a roll-bar or a roll-cage within the 'B-zone', must have:

(a) *a head restraint fitted to provide protection for each occupant where a roll-bar or roll-cage section exists immediately behind a seat, positioned between the occupant seating position and the roll-bar or roll-cage section; and*

16.14

A roll-bar is defined as a main hoop behind the front row of seats, with any supporting bars going rearward, although can include 'hip-bars'. (These are bars that run longitudinally from mid-way up the hoop to the bottom of the A-pillar).

A roll-cage is a roll-bar with additional bars running forward around the top of the vehicle's interior.

16.14.2

This means that fixed-roof unitary constructed passenger cars can't have a roll-cage without an LVV Authority Card. See 'Useful Information' section at the back of this chapter for more information on Authority Cards.

In the hobby car world, this means that you can have a roll-cage in open or convertible vehicles; or vehicles with a roof structure not designed for roll-over protection such as those with a fibreglass body. Also, off-road-type 4WD vehicles, and any vehicles with a separate body/chassis can all have a roll-cage.

Don't forget though, the 'A-zone' clear space requirements still apply in all cases.

(b) *no unprotected hard or sharp bracketry including a roll-bar or roll-cage mount, seatbelt mount, or fastener positioned where it would be likely to be contacted by an occupant in the event of an impact or roll-over; and*

(c) *all sections of a roll-bar or a roll-cage positioned adjacent to any A-Zone covered in a high-density energy-absorbing material which:*

(i) *meets SFI specification 45.1 or another equivalent motor-sporting specification; and*

(ii) *is not less than 15 mm (5/8") in thickness in the area facing the occupant cell.*

'C-zone' interior equipment requirements

16.15 'C-zone' interior equipment design

16.15.1

All interior fittings, controls, and surfaces within the 'C-Zone' of a low volume vehicle passenger compartment must be designed so that the likelihood of injury to occupants is minimised.

Additional requirements for other interior equipment

16.16 Roof and pillar sections

16.16.1

Surfaces within the roof and side pillar area of a low volume vehicle including roof bows, pillars, cant rails, and header rails which face the passenger compartment must:

(a) *have any exposed edges or corners of any solid sections provided with a radius of not less than 3 mm (1/8"); and*

(b) *have any exposed handles, support brackets, or other protrusions attached to the pillars or header rails:*

(i) *constructed of, or covered by, a high-density energy-absorbing material; and*

(ii) *provided with a radius of not less than 3 mm (1/8") on all corners and edges.*

16.17 Sun-visors

16.17.1

A low volume vehicle must be fitted with an effective and adjustable sun-visor for the use of the driver, unless:

(a) *due to the design of the vehicle, a sun-visor cannot be practicably fitted; or*

(b) *there is insufficient available interior space or windscreen height for a sun-visor to operate effectively and safely.*

16.17.2

A sun-visor assembly, complete with its attachment structure, sourced from a production vehicle may be fitted to a low volume vehicle, provided that:

(a) *the vehicle to which the sun-visor assembly was originally fitted was manufactured in:*

(i) *the United States of America on or after 1 January 1981; or*

(ii) *Europe or the United Kingdom on or after 1 January 1974; or*

(iii) *Japan on or after 1 January 1983; or*

(iv) *Australia on or after 1 January 1988;*

and

(b) *the sun-visor assembly is mounted so as to replicate the location and installation method employed by the donor vehicle manufacturer; and*

(c) *the sun-visor assembly is unmodified.*

16.17.3

A sun-visor assembly fitted to a low volume vehicle may be sourced elsewhere provided that:

(a) the surface of the sun-visor is made from a deformable material and has all corners and edges provided with a radius of no less than 3 mm (1/8”); and

(b) any mounting brackets and fittings which incorporate hard edges or protrusions have a radius of no less than 3 mm (1/8”).

16.18 Door panels and armrests

16.18.1

No door panels or other interior trim may be removed from the interior of a low volume vehicle, in doing so exposing any surfaces or fittings that could increase the risk of injury to occupants in the event of contact, unless the substitution of other protective paneling occurs.

16.18.2

An armrest fitted to the interior of a low volume vehicle must:

(a) *have corners and edges provided with a radius of no less than 3 mm (1/8"); or*

(b) *be covered with a high-density energy-absorbing material of no less than 5 mm (3/16") thickness.*

16.19 Door and window handles

16.19.1

A handle fitted to the interior of a low volume vehicle, such as a door opener or window winder, must:

(a) *be of a design that will deflect contact; and*

(b) *have a radius provided on all edges; and*

(c) *not protrude from the door panel surface by any more than 35 mm (1 3/8").*

16.20 Rear View Mirrors

16.20.1

A rear view mirror fitted within the passenger compartment of a low volume vehicle must meet any applicable requirements for rear view mirrors specified in 'Chapter 15 - Glazing and Vision'.

16.21 Park brake levers and gear levers

16.21.1

A gear lever or park brake lever fitted to a low volume vehicle, whilst in the fully released position, must:

(a) *be designed and constructed so as to minimise the risk of injury to occupants in the event of contact; and*

(b) *not have associated linkages, flanges, mounting brackets, or shafts, protruding in such a way as to increase the risk of injury to occupants in the event of contact.*

16.22 Dry-sump systems

16.22.1

A dry-sump oiling system tank and associated fittings and lines, if fitted in the passenger compartment of a low volume vehicle, must comply with the applicable safety requirements of Schedule A of the current MotorSport New Zealand Manual.

Exclusions:

16.23 Period equipment exclusions

16.23.1

Standard or optional equipment that was available at the time of a mass-produced vehicle's manufacture, when fitted to a modified production low volume vehicle for which that equipment is designed, is not required to comply with 16.7 and 16.12.

16.23.1

This means that genuine period manufacturer or aftermarket accessories such as tissue dispensers, record players, and spot lamp handles do not have to comply with 16.7 and 16.12.

16.24 LVV Authority Card exclusions

16.24.1

A low volume vehicle, for which a valid Low Volume Vehicle LVV Authority Card is issued by an LVVTA-approved organisation, that specifies 'Competition Occupant Protection System' is issued, is not required to comply with 16.4 to 16.21.

16.24.1

See 'Useful Information' section for more information on LVV Authority Cards for fenders, roll-cages, and other items.

16.25 Build or modification date exclusions

16.25.1

A low volume vehicle that was built or modified prior to 1992 is not required to comply with 16.4 to 16.14, or 16.16 to 16.21.

16.25.1

A low volume vehicle built or modified before January 1992 is only required to comply with 16.15.

Useful Information:

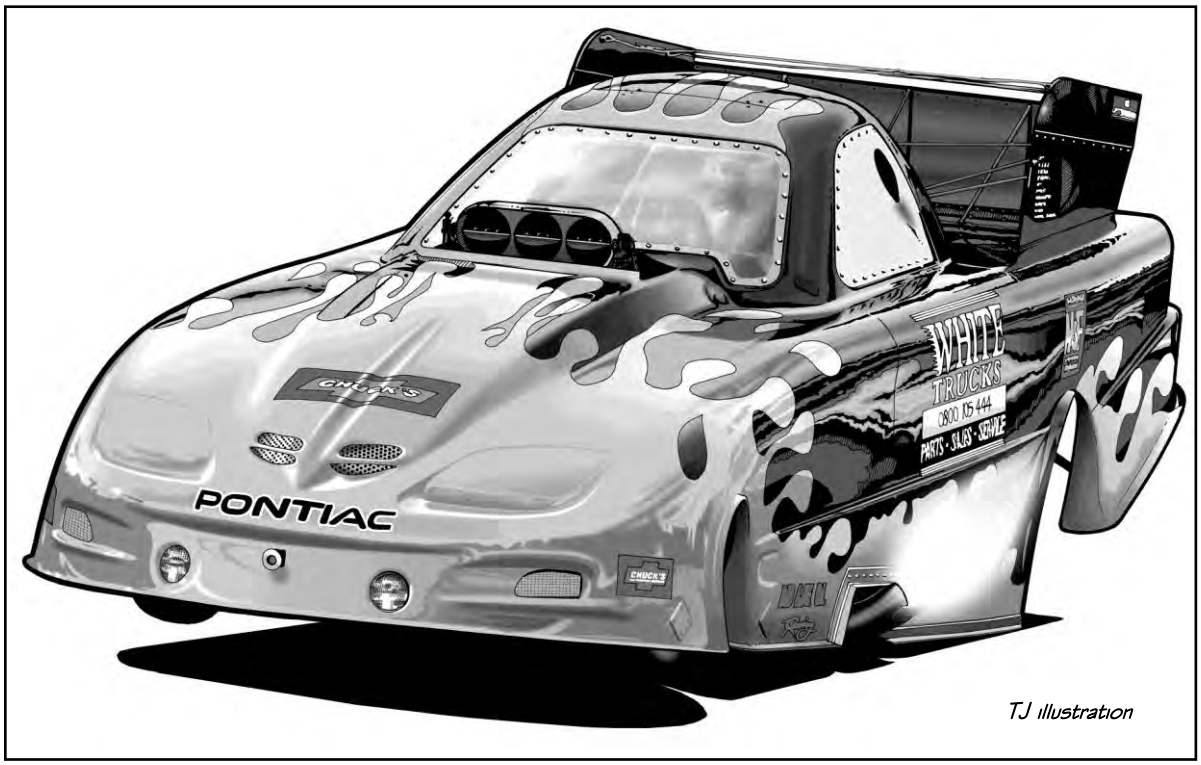
LVV Authority cards

A Low Volume Vehicle Authority Card is only available for a vehicle that is modified for a particular purpose, in order to meet the specific needs of the person nominated on the Authority Card. LVV Authority Cards can be issued only by the New Zealand Hot Rod Association, and by MotorSport New Zealand.

New Zealand Hot Rod Association's Authority Card covers fenderless vehicles, and vehicles that are required by NZHRA's and the New Zealand Drag Racing Association's safety requirements to have a roll-cage.

MotorSport New Zealand can issue LVV Authority Cards for various types of equipment that are applicable to their competition vehicles, such as roll-cages, navigational equipment, and hydraulic park brakes.

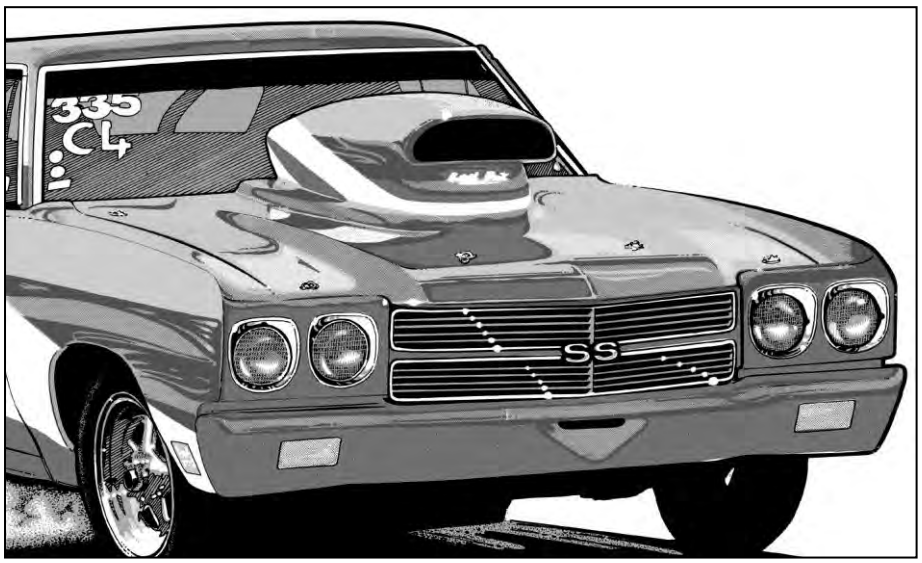
See 'Chapter 3 – Authority Card Process' for all of the details on the NZHRA LVV Authority Card system. The operator of a vehicle for which an LVVTA-approved Authority Card is issued, must, when requested by an enforcement officer or LVV certifier, produce the Authority Card for that vehicle.



TJ illustration

Chapter 17:

LIGHTING EQUIPMENT



TJ illustration

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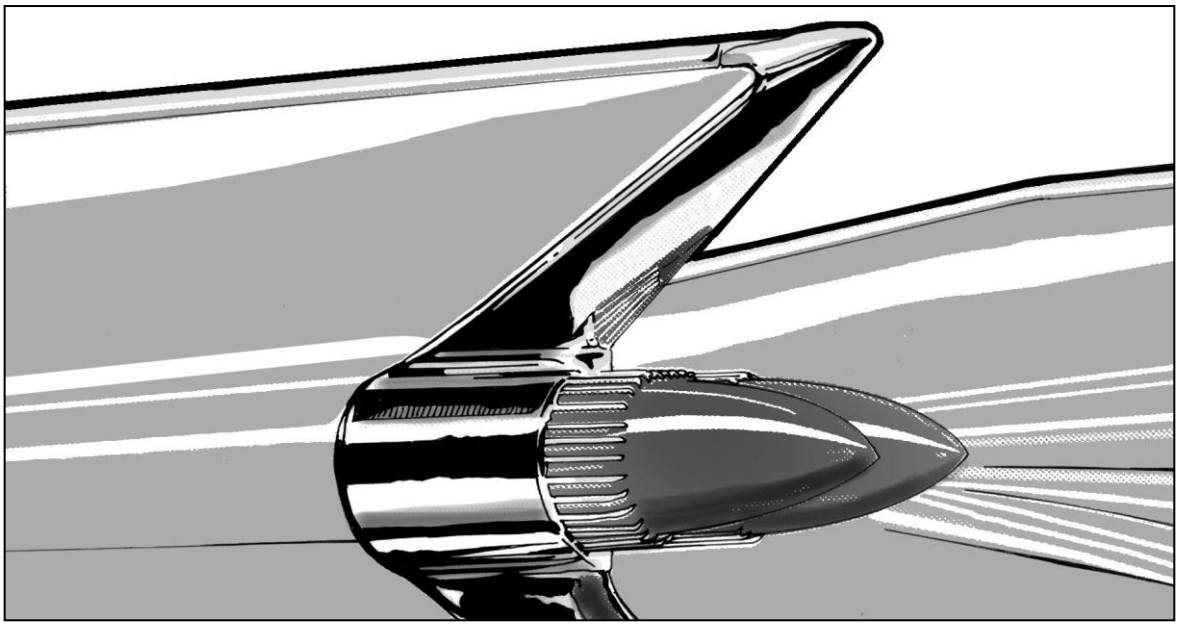
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Key: (for full key details, refer to 'Chapter 2 – About this Manual')

Normal type: Provisions of the NZ Car Construction Manual for all vehicles
Normal type in shaded box: Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates
Italic type: *Extracts from any relevant LVVTA Low Volume Vehicle Standards*
Script type: Helpful hints, tips, explanations, clarifications, and interpretations
Shaded text & dotted vertical stroke in margin: Latest amendments since previous version



TJ illustration

CHAPTER 17: LIGHTING EQUIPMENT

Introduction:

The purpose of this low volume vehicle standard is to specify safety requirements for lamps that are added, substituted, or modified, and their installation on a low volume vehicle, that will provide safe driving visibility to the driver, and that will increase the conspicuousness of the vehicle for other road users during all driving conditions and weather types. Note that where a production vehicle is fitted with its original lamps in their original location, the requirements in this chapter do not apply.

Design & construction requirements for all lamps

17.1 Design and construction of all lamps

17.1.1

A lamp fitted to a low volume vehicle must be:

(a) *constructed or coated so as to be corrosion resistant; and*

(b) *designed, manufactured, and assembled in such a way as to prevent the entry of moisture or foreign material.*

17.1.2

A lamp fitted to a low volume vehicle must be designed and attached so as to enable ready access for replacement of bulbs.

17.2 Attachment and positioning of all lamps

17.2.1

A lamp fitted to a low volume vehicle must be:

(a) *securely mounted; and*

(b) *free from vibration; and*

(c) *correctly aligned.*

17.2.2

A lamp that is required by this low volume vehicle standard to be fitted to a low volume vehicle must not be obscured by any modifications to the vehicle, fitment of additional equipment, or the carriage of any load.

17.2.3

A lamp fitted to a low volume vehicle, other than a headlamp or fog-lamp, must not be concealed when not in use.

17.3 Colour of all lamps

17.3.1

A low volume vehicle must not be fitted with lighting equipment that emits red light that is directly visible from the front of the vehicle.

17.3.2

A low volume vehicle must not be fitted with, except for reversing lamps, a lamp or reflector that emits or reflects other than red or amber light if the light is directly visible from the rear of the vehicle.

17.3.3

Lighting equipment that is fitted as a pair to the front or to the rear of a low volume vehicle must emit light of approximately equal colour when operated.

17.4 Performance of all lamps

17.4.1

Lighting equipment fitted to a low volume vehicle must be:

(a) *in sound condition and good working order; and*

(b) *in the case of an LED array, have no more than 25% of the LEDs not working.*

17.4.2

The light emitted from a lamp fitted to a low volume vehicle, other than from a direction indicator, must be steady.

17.4.3

Lighting equipment that is fitted as a pair to the front or to the rear of a low volume vehicle must emit light of approximately equal intensity when operated.

17.4.4

Lighting equipment fitted to a low volume vehicle must be capable of providing sufficient illumination, light output or light reflection to:

(a) *fulfil its intended purpose; and*

(b) *enable the vehicle to which it is fitted to be operated safely on a road.*

17.5 Overlays

17.5.1

An overlay must not be applied to a lens fitted to a low volume vehicle if that overlay would reduce the mechanical and optical properties of the lamp below a safe tolerance.

17.5.1

Provided that an overlay is completely clear with no colouring or tinting, as is the case with most commercially manufactured adhesive protective overlays, the requirements specified in 17.5.1 will be met.

17.6

Headlamps are the most important part of a low volume vehicle's lighting system, as they affect the driver's vision, the vehicle's conspicuousness, and oncoming motorists' ability to see without being dazzled. As such, there can be no compromises in relation to headlamps on a low volume vehicle for any reason.

A vehicle must have dipped-beam headlamps, but main-beam headlamps are not actually a legal requirement.

17.6.2

See the 'Motorsport exclusions' in 17.82 at the back of this chapter for those vehicles which may be fitted with additional lamps than specified in 17.6.2.

Headlamp requirements

17.6 Number of headlamps

17.6.1

A low volume vehicle must be fitted with one pair of dipped-beam headlamps.

17.6.2

A low volume vehicle is not required to be fitted with main-beam headlamps, but if fitted, may have one or two pairs of main-beam headlamps.

17.7 Colour of headlamps

17.7.1

When operated, a headlamp that is fitted to a low volume vehicle must emit a beam of light that is substantially white or amber.

17.8 Positioning of headlamps

17.8.1

A pair of headlamps that are fitted to a low volume vehicle must be:

(a) *positioned at the front of the vehicle; and*

(b) *symmetrically arranged.*

17.8.2

A pair of dipped-beam headlamps fitted to a low volume vehicle must be positioned at a width and height that is in accordance with the requirements specified in Table 17.1.

17.8.3

A pair of main-beam headlamps fitted to a low volume vehicle may be positioned at any width or height.

17.8.3

This includes the fitment of roof-mounted high-beam headlamps on an off-road vehicle.

ORIENTATION	REQUIREMENTS
Width:	▪ no further inboard than 400 mm (16") from the outer-most part of the vehicle; or
	▪ in the case of a low volume vehicle that is less than 1300 mm (53") in width, no less than 400 mm (16") apart; or
	▪ in the case of a low volume vehicle whose body design makes achieving this impractical, no less than 600 mm (24") apart; or
	▪ in the case of a vehicle for which a valid LVV Authority Card issued by the New Zealand Hot Rod Association (Inc) has been issued that specifies 'mudguard exemption', closer to the vertical centreline of the adjacent tyre than to the longitudinal centreline of the vehicle.*
Height:	▪ no less than 250 mm (10") from the ground; and
	▪ no more than 1500 mm (61") from the ground.

Notes to accompany table 17.1

- All lamps fitted to a low volume vehicle must be positioned as far toward the outer edges of the vehicle as practicable, so as to reasonably indicate to other road users at night, the approximate width of the vehicle.
- *This means that the distance from the lamp to the centreline of the tyre is less than the distance from the lamp to the vehicle centreline.

Table 17.1 Positioning of lamps

17.9 Operation of headlamps

17.9.1

A main-beam headlamp fitted to a low volume vehicle must be able to be dipped or extinguished from the driver's seating position.

17.9.2

A low volume vehicle fitted with main-beam headlamps must be fitted with an internal warning light that is blue in colour, which indicates to the driver that the main-beam headlamps are in operation.

17.9.2

A modified production low volume vehicle may be fitted with a main-beam warning light of any colour, provided that the light was fitted as original equipment by the vehicle manufacturer.

17.10 Electrical connections for headlamps

17.10.1

The wiring system in a low volume vehicle that is fitted with main-beam headlamps, must extinguish the main-beam headlamps when the dipped-beam headlamps are operated.

17.10.2

The wiring system in a low volume vehicle that is fitted with main-beam headlamps, may enable a dipped-beam headlamp to remain illuminated when the main-beam headlamps are operating.

17.10.3

Activation of either the dipped-beam or main-beam headlamps in a low volume vehicle must automatically also activate the:

(a) *rearward-facing position lamps; and*

(b) *registration-plate illumination-lamps.*

17.11 Adjustment of headlamps

17.11.1

A headlamp assembly in a high volume vehicle must:

(a) *be aligned so as to meet the New Zealand Transport Agency's alignment requirements; and*

(b) *be designed and installed so as to incorporate sufficient provision for adjustment in order to meet the requirement of 17.11.1(a), and continue to meet these requirements despite any changes of height and loading that may occur during the life of the vehicle.*

17.12 Headlamp sources

17.12.1

A filament bulb or high-intensity gas discharge headlamp fitted to a low volume vehicle, other than one built or modified before January 1992, must comply with any one or more of the approved standards specified for headlamps listed in Table 17.2, by either incorporating the applicable standards markings on the headlamp lens, or through other supplementary documented evidence. (see Table 17.2)

LAMP TYPE	UN/ECE Regulation No:	European Council Directive	Australian Design Rule	Federal Motor Vehicle Safety standard	Japanese Technical Standard	Japanese Industrial Standard
▪ Headlamps	UN/ECE 1, 5, 8, 20, 31, 98, 112, 113	76/761/EEC	ADR 47	FMVSS 108	Technical Std for Headlamps (Japan)	JIS D5504, JIS D5500
▪ Stop-lamps	UN/ECE 7	76/758/EEC	ADR 49	FMVSS 108	Technical Std for Lamps (Japan)	JIS D5500
▪ High-mounted stop-lamps	UN/ECE 7		ADR 60	FMVSS 108	Technical Std for Auxiliary Stop Lamps (Japan)	JIS D5500
▪ Direction-indicators	UN/ECE 6	75/759/EEC	ADR 6	FMVSS 108	Technical Std for Direction Indicators (Japan)	JIS D5500
▪ Forward-facing position-(park) lamps	UN/ECE 7	76/758/EEC	ADR 49	FMVSS 108	Technical Std for F&R Position (Side) Lamps (Japan)	JIS D5500
▪ Rearward-facing position-(park) lamps	UN/ECE 7	76/758/EEC	ADR 49	FMVSS 108	Technical Std for Front & Rear Position (Side) Lamps (Japan)	JIS D5500
▪ Rear registration-plate illumination-lamps	UN/ECE 4	76/760/EEC	ADR 48	FMVSS 108	Technical Std for Number Plate Lamps (Japan)	JIS D5500
▪ Retro-reflectors	UN/ECE 3	76/757/EEC	ADR 47	FMVSS 108	Technical Std for Rear Reflex Reflectors (Japan)	JIS D5500
▪ Daytime running-lamps	UN/ECE 87	---	ADR 45, ADR 76	FMVSS 108	---	---
▪ Reversing-lamps	UN/ECE 23	77/539/EEC	ADR 1	FMVSS 108	Technical Std for Back-up Lamps (Japan)	JIS D5500
▪ Fog-lamps	UN/ECE 19	76/762/EEC	ADR 50	FMVSS 108	Technical Std for Front Fog Lamps (Japan)	JIS D5500

Notes to accompany table 17.2

- 'DOT' marked on a lamp lens denotes that the lamp complies with an FMVSS Standard listed in this table.

Table 17.2 Approved standards for lamps

17.12.2

A filament bulb headlamp that does not meet an approved standard specified in Table 17.2 may be fitted to a modified production low volume vehicle, or a scratch-built 'historic replica' low volume vehicle, provided that the lamp lens:

(a) *either:*

(i) *was fitted to a production vehicle as original equipment; or*

(ii) *is manufactured from glass, by an aftermarket lamp manufacturer as a direct replacement for an original equipment lamp fitted to a production vehicle;*

and

(b) *the production vehicle for which the lamp is manufactured is a later model vehicle than the low volume vehicle to which the lamp is fitted, or in the case of a scratch-built 'historic replica' low volume vehicle, the vehicle being replicated.*

17.12.2(b)

This means where a lamp from a production vehicle is fitted, the lamp must always be from a later-model vehicle, and not an older vehicle, so that the lighting performance of the modified vehicle is always increased, not decreased, as a result of the lamp retro-fitment.

A low volume vehicle built or modified before January 1992 is not required to have headlamps that comply with an approved standard.

17.13.1

17.13 Modern headlamps in old housings

17.13.1

A modified production low volume vehicle, or a scratch-built 'historic replica' low volume vehicle, may incorporate a modern headlamp within an old headlamp housing in order to achieve modern headlamp performance and period aesthetics, provided that:

(a) *the performance of the headlamp exceeds that of the headlamp originally fitted to the vehicle; and*

(b) *the lens fitted to the old headlamp does not adversely affect the optical properties and performance of the modern headlamp; and*

(c) *the installation does not prevent the headlamp from complying with any other headlamp requirement.*

In order to comply with 17.13.1, it will usually be necessary to either replace the old factory-supplied lens with un-patterned clear glass, or remove the lens from the new headlamp, so that the new lamp reflector and bulb projects directly through the old lens.

17.13.1(b)

A Low Volume Vehicle Certifier may accept receipt of documented evidence that the vehicle has been approved for a WOF or COF by an Authorised Vehicle Inspector as verification of compliance with 17.13.1(b).

17.14 Concealed headlamps

17.14.1

A low volume vehicle may be fitted with concealed headlamps, provided that:

(a) *a single switching operation both activates the movement of the headlamp assemblies into position, and illuminates the headlamps; and*

(b) *in the event of a failure of the mechanism that moves the lamps into their operating position;*

(i) *the lamp assemblies can be moved into, and will remain located in, their operating positions without the use of tools; and*

(ii) *the lamps will still illuminate.*

17.15 Swivelling headlamps

17.15.1

A headlamp fitted to a low volume vehicle may be mechanically controlled by the steered wheels to swivel in the horizontal plane, provided that:

(a) *only the main-beam headlamps are able to swivel; and*

(b) *the dipped-beam headlamps remain fixed; and*

(c) *the headlamp alignment meets the visibility requirements specified in 17.11.1 whilst the steered wheels are in the straight-ahead position.*

17.16 Headlamp compatibility

17.16.1

A bulb fitted to a headlamp in a low volume vehicle must be of a type that is compatible with the bulb holder, lamp housing, and lens.

17.16.2

A dipped-beam headlamp designed solely for a left-hand drive motor vehicle, where the maximum intensity of the beam is dispersed to the right, must not be fitted to a low volume vehicle.

17.17 Headlamp shields and covers

17.17.1

A low volume vehicle may incorporate a headlamp positioned behind a permanent protective shield, provided that:

(a) *the protective shield is either:*

17.16.1

This refers in particular to the fitting of HID (high intensity discharge) bulbs to normal lamp housings. HID bulbs are not compatible with regular lamps, as this combination greatly increases levels of glare to other road users, and therefore HID bulbs must not be retro-fitted to housings that were not designed to be used with HID bulbs.

Fitment of quartz halogen bulbs into regular lamps are generally a successful, and therefore acceptable, retro-fitment. However, the wattage of any headlamp bulb should not exceed 65 watts.

(i) *manufactured from a clear transparent material that is in good unmarked condition; or*

(ii) *an open wire mesh designed for use as a stone guard;*

and

(b) *the protective shield does not prevent the headlamp from complying with any other headlamp requirements.*

17.17.2

A headlamp fitted to a low volume vehicle may be covered by a readily removable protective cover when it is not in use.

Stop-lamp requirements

17.18 Number of stop-lamps

17.18.1

A low volume vehicle must be fitted with either one or two pairs of stop-lamps.

See the 'Stop-lamp exclusions' in 17.83 at the back of this chapter for those vehicles which may be fitted with a single stop-lamp.

17.19 Colour of stop-lamps

17.19.1

When operated, a stop-lamp fitted to a low volume vehicle must emit diffuse light that is substantially red.

17.20 Positioning of stop-lamps

17.20.1

A stop-lamp fitted to a low volume vehicle must be positioned to the rear of the vehicle.

17.20.2

A pair of stop-lamps fitted to a low volume vehicle must be symmetrically arranged.

17.20.3

A pair of stop-lamps fitted to a low volume vehicle must be positioned at a width and height that is in accordance with the requirements specified in Table 17.1.

17.21 Operation of stop-lamps

17.21.1

A stop-lamp fitted to a low volume vehicle must illuminate when the vehicle's ignition system is on, and the service brake is applied.

17.22 Visibility (output) of stop-lamps

17.22.1

A stop-lamp fitted to a low volume vehicle must, when in operation, provide an output of not less than:

(a) *in the case of a filament bulb, 20 watts; or*

(b) *in the case of an LED array, equivalent brightness to a 20 watt filament bulb stop-lamp.*

17.22.2

A stop-lamp fitted to a low volume vehicle must, when in operation, emit light that is clearly visible during conditions of clear daylight, from a distance of 100 m (328') directly behind the vehicle.

17.22.3

A stop-lamp fitted to a low volume vehicle must, when both the stop-lamps and rearward-facing position-lamps are illuminated, be visibly and substantially brighter than the rearward-facing position-lamps.

17.23 Visibility (angles) of stop-lamps

17.23.1

A stop-lamp fitted to a low volume vehicle, other than one built or modified before January 1992, must, when operated, emit light that is visible within an angle of at least:

(a) *on a horizontal plane passing through the lamp:*

(i) *15 degrees above; and*

(ii) *15 degrees below;*

and

(b) *45 degrees either side of a vertical plane that is parallel to the longitudinal centre-line of the vehicle and passing through the lamp. (see Diagram 17.1)*

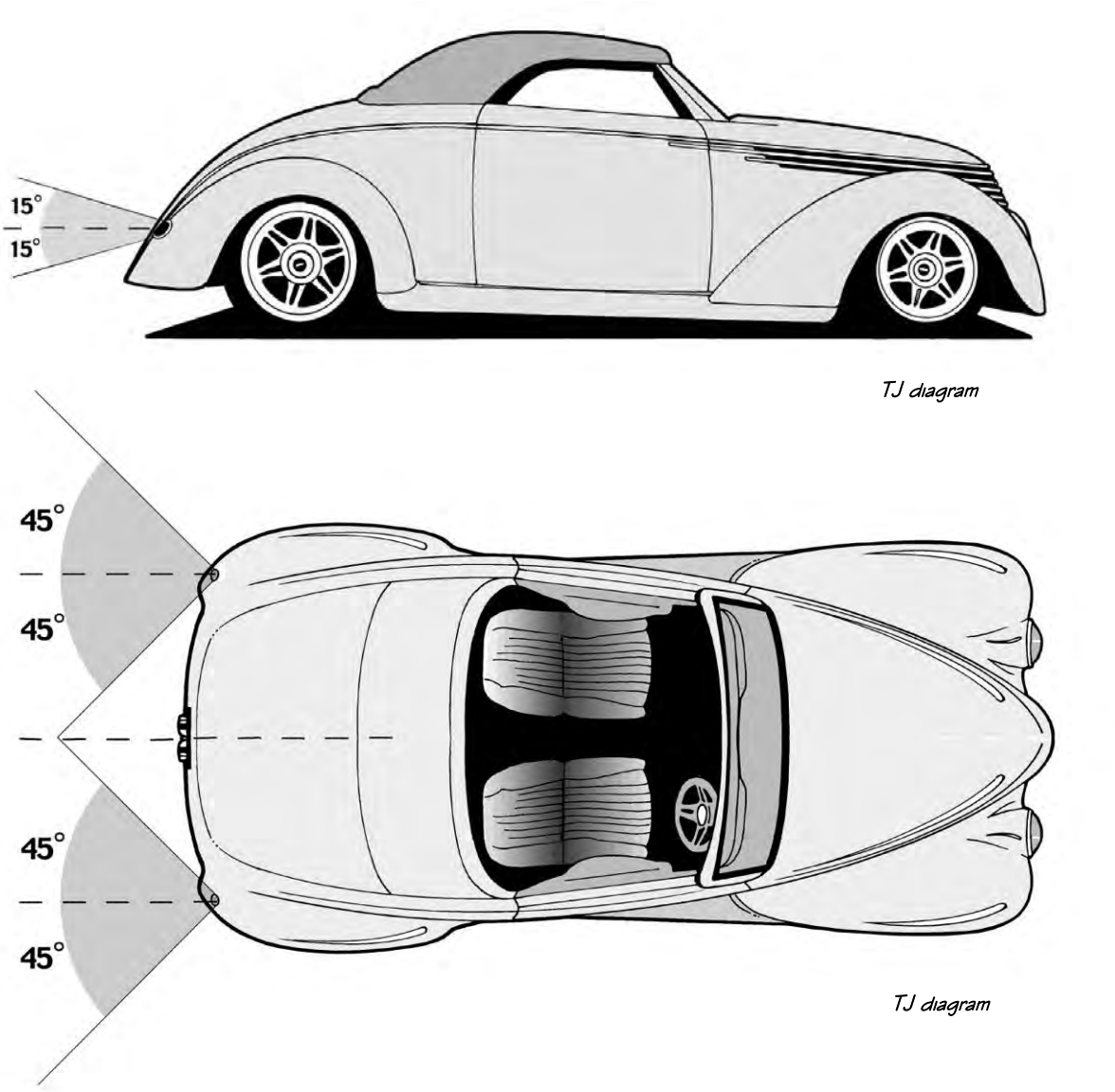


Diagram 17.1 Visibility angles for stop-lamps

17.24 Size of stop-lamps

17.24.1

A stop-lamp fitted to a low volume vehicle must incorporate a luminous lens surface area of not less than:

(a) *in the case of a filament bulb, 22 sq cm (3 ½ sq"); or*

(b) *in the case of an LED array, sufficient area so as to provide at least equivalent conspicuousness as a filament bulb specified in 17.24.1(a).*

17.25 Stop-lamp sources

17.25.1

A filament bulb or LED array stop-lamp fitted to a low volume vehicle, other than one built or modified before January 1992, must comply with any one or more of the approved standards specified for stop-lamps listed in Table 17.2, by either incorporating the applicable standards markings on the stop-lamp lens, or through other supplementary documented evidence. (see Table 17.2)

17.25.2

A filament bulb or LED array stop-lamp fitted to a low volume vehicle, other than one built or modified before January 1992, that does not meet any one or more of the approved standards listed in Table 17.2, may be fitted provided that the lamp meets the requirements specified in Table 17.3.

LAMP SOURCE	REQUIREMENTS
Lamps (filament bulb) sourced from production vehicles with no standards markings – OK if:	▪ was fitted to a production vehicle as original equipment; or ▪ lens is manufactured from glass, by an aftermarket lamp manufacturer as a direct replacement for an OE production vehicle lamp; and
	▪ the production vehicle for which the lamp is manufactured is a later model vehicle than the low volume vehicle to which the lamp is fitted (or in the case of a scratch-built low volume vehicle, the vehicle being replicated);* and
	▪ in the case of a lamp that does not incorporate a reflector or reflectorised housing behind the bulb, reflected light is maximized by either: ➢ covering the face of the lamp housing behind the bulb with reflective aluminium tape;** or ➢ installing a reflector disc behind the bulb.
Custom-manufactured (filament bulb) lamp OK if:	▪ made from materials and incorporates components that are resistant to atmospheric and weather degradation, in particular elastomeric materials used for weather sealing; and
	▪ lens is either: ➢ part of a OE lamp fitted to a production vehicle which meets an approved standards specified in Table17.2; or *** ➢ custom-manufactured from sheet material, and documented evidence is provided to the LVV certifier to substantiate that the optical properties and ultra-violet light resistance of the sheet-material is acceptable.****
Custom-manufactured (LED array) OK if:	▪ lamp has been assessed and approved in writing by the Low Volume Vehicle Technical Association (Inc) as complying with specified photometric and other performance requirements.*****

Notes to accompany Table 17.3

- *This requires that where a lamp from a production vehicle is fitted, the lamp must always be from a later-model vehicle, and not an older vehicle, so that the lighting performance of the modified vehicle is always increased, and not decreased, as a result of the lamp retro-fitment.
- **The application of aluminium tape is successful only where the body of the housing is flat or tapered. Where a bulb sits within a deep recess in the housing with predominantly vertical sides, a reflector disc should be installed rather than tape.
- ***If a stop-lamp lens is custom-made from a part of an OE lamp from a production vehicle, and the custom-made lens does not incorporate the approved standards markings from the OE lens, the remainder of the OE lens (from which the custom-made stop-lamp lens is cut) should be retained and made available to the LVV certifier in order to verify to the LVV certifier the origin of the custom-made lens.
- ****In such cases, LVVTA should be consulted to confirm the suitability of the material.
- *****Over-intensity is an inherent potential problem with a custom-manufactured LED array lamp, and such a lamp cannot be correctly assessed without photometric laboratory testing on a case-by-case basis.
- This table does not apply to headlamps, high-mounted stop-lamps, and retro-reflectors.

Table 17.3 Lamp sources

A low volume vehicle built or modified before January 1992 is not required to have stop-lamps that comply with an approved standard, or that meet the requirements of Table 17.3.

17.26 Blue-dot inserts for stop-lamps

17.26.1

A stop-lamp fitted to a low volume vehicle must not incorporate a blue-dot accessory insert within the lens.

High-mounted stop-lamp requirements

17.27 Number of high-mounted stop-lamps

17.27.1

A low volume vehicle of Class-MA manufactured on or after 1 January 1990 must be fitted with one high-mounted stop-lamp.

17.27

The New Zealand entry compliance process requires that any MA-class vehicle (irrespective of age) first registered in New Zealand on or after 1 January 1990 must be fitted with a high-mounted stop-lamp.

'MA-class' means any passenger car or station wagon.

A low volume vehicle is not required to be fitted with a high-mounted stop-lamp if the vehicle was either manufactured before 1 January 1990, or is of a class other than MA.

17.28 Colour of high-mounted stop-lamps

17.28.1

When operated, a high-mounted stop-lamp fitted to a low volume vehicle must emit diffuse light that is substantially red.

17.29 Positioning of high-mounted stop-lamps

17.29.1

A high-mounted stop-lamp fitted to a low volume vehicle must be fitted:

(a) *in a central high-mounted position at the rear of the vehicle, so that no part of its illuminated area is lower than 150 mm (6") below the bottom edge of the rear window of the vehicle; or*

(b) *in the case of a vehicle that does not have a rear window, in a central high-mounted position at the rear of the vehicle.*

17.30 Size of high-mounted stop-lamps

17.30.1

A high-mounted stop-lamp fitted to a low volume vehicle must be:

(a) *not less than 22 sq cms (3 ½ sq "); and*

(b) *predominantly rectangular in shape.*

17.31 Operation of high-mounted stop-lamps

17.31.1

A high-mounted stop-lamp fitted to a low volume vehicle must illuminate:

(a) *when the vehicle's ignition system is on, and the service brake is applied; and*

(b) *in conjunction with the main stop-lamps.*

17.32 Visibility of high-mounted stop-lamps

17.32.1

A high-mounted stop-lamp fitted to a low volume vehicle must, when in operation, provide an output of not less than:

(a) *in the case of a filament bulb, 15 watts; or*

(b) *in the case of an LED array, equivalent brightness to a 15 watt filament bulb high-mounted stop-lamp.*

17.32.2

A high-mounted stop-lamp fitted to a low volume vehicle must, when in operation, emit light that is clearly visible during conditions of clear daylight, from a distance of 100 m (328') directly behind the vehicle.

17.33 High-mounted stop-lamp sources

17.33.1

A filament bulb or LED array high-mounted stop-lamp may be fitted to a low volume vehicle, provided that the lamp is proven to comply with any one or more of the approved standards specified for high-mounted stop-lamps listed in Table 17.2, by either incorporating the applicable standards markings on the high-mounted stop-lamp lens, or through other supplementary documented evidence. (see Table 17.2)

17.33.2

A filament bulb high-mounted stop-lamp that is custom-manufactured, must be made from materials and incorporate components, that are resistant to atmospheric and weather degradation, in particular elastomeric materials used for weather sealing.

17.33.3

A lens for a filament bulb high-mounted stop-lamp that is custom-manufactured, may be fitted to a low volume vehicle, provided that either:

(a) *the lens is part of a stop-lamp, high-mounted stop-lamp, or rearward-facing position-lamp lens that was fitted to a post-1979 production vehicle as original equipment when the vehicle was manufactured; or*

(b) *in the case of a lens custom-manufactured from sheet material, the lens is supported by documented evidence to the LVV Certifier to substantiate that the optical properties and ultra-violet light resistance of the sheet material is acceptable.*

17.33.4

A custom-manufactured LED-array high-mounted stop-lamp must not be fitted to a low volume vehicle unless the lamp has been assessed and approved in writing by the Low Volume Technical Association (Inc) as complying with specified photometric and other performance requirements.

17.33.3

If a high-mounted stop-lamp lens is custom-made from a part of an OE lamp from a production vehicle, and the custom-made high-mounted stop-lamp lens does not incorporate the approved standards markings from the OE lens, the remainder of the OE lens from which the custom-made high-mounted stop-lamp lens is cut should be retained and made available to the LVV Certifier in order to verify the origin of the custom-made lens.

Where 17.33.3(a) applies, the LVVTA should be consulted to confirm the suitability of the material.

17.33.4

Over-intensity is an inherent potential problem with a custom-manufactured LED array lamp, and such a lamp cannot be correctly assessed without photometric laboratory testing on a case-by-case basis.

Direction-indicator lamp requirements

17.34 Number of direction-indicator lamps

17.34.1

A low volume vehicle must be fitted with one or two pairs of direction-indicator lamps to the front, and one or two pairs of direction-indicator lamps to the rear of the vehicle.

See the 'Direction-indicator lamp exclusions' in 17.84 at the back of this chapter for those vehicles which are not required to be fitted with direction-indicators.

17.35 Colour of direction-indicator lamps

17.35.1

When operated, a forward-facing direction-indicator lamp fitted to a low volume vehicle must emit a flashing light that is substantially white or amber.

17.35.2

When operated, a rearward-facing direction-indicator lamp fitted to a low volume vehicle must emit a flashing light that is substantially red or amber.

17.35.3

When operated, if fitted, a side-facing direction-indicator lamp fitted to a low volume vehicle must emit a flashing light that is substantially amber.

17.36 Positioning of direction-indicator lamps

17.36.1

A pair of direction-indicator lamps fitted to a low volume vehicle must be symmetrically arranged.

17.36.2

A direction-indicator lamp fitted to the front of a low volume vehicle must be positioned within a housing that is separate to the headlamp housing, so that the performance of both the direction-indicator and the headlamp cannot adversely affect each other.

17.36.3

A pair of direction-indicator lamps fitted to a low volume vehicle, other than one built or modified before January 1992, must be positioned at a width and height that is in accordance with the requirements specified in Table 17.1.

17.37 Size of direction-indicator lamps

17.37.1

A direction-indicator lamp fitted to a low volume vehicle must incorporate a luminous lens surface area of not less than:

(a) *in the case of a filament bulb, 22 sq cm (3 ½ sq "); or*

(b) *in the case of an LED array, sufficient area so as to provide at least equivalent conspicuity as a filament bulb specified in 17.37.1(a).*

17.38 Operation of direction-indicator lamps

17.38.1

The light emitted from a direction-indicator fitted to a low volume vehicle must operate at a fixed frequency of:

(a) *not less than 60 flashes per minute; and*

(b) *not more than 120 flashes per minute.*

17.38.2

A direction-indicator system fitted to a low volume vehicle must incorporate, either visually or audibly, when in operation:

(a) *a warning system to inform the driver that the direction-indicator lamps are in operation; and*

(b) *a warning system to inform the driver of the failure of one or more bulbs within the direction-indicator system.*

17.38.3

A direction-indicator system fitted to a low volume vehicle must:

(a) *flash each direction-indicator within the system in phase with each other; and*

(b) *switch all direction-indicator lamps on either side of the vehicle on and off together with a single control.*

17.39 Electrical connections for direction-indicator lamps

17.39.1

A direction-indicator fitted to the rear of a low volume vehicle may be either:

(a) *an individual item of lighting equipment; or*

(b) *incorporated within the rearward-facing position-lamp and stop-lamp circuits, so that when in operation, the direction-indicator illuminates or cancels, as necessary, the rearward-facing position-lamp and stop-lamp.*

17.39.2

A low volume vehicle may be fitted with a switching device that activates all direction-indicator lamps simultaneously to function as hazard lamps.

17.39.1(b)

A direction-indicator incorporated within the rearward-facing position-lamp is the standard system that has been used in the American automobile industry for many decades.

17.40 Visibility (output) of direction-indicator lamps

17.40.1

A direction-indicator lamp fitted to a low volume vehicle must, when in operation, provide an output of not less than:

(a) *in the case of a filament bulb, 15 watts; or*

(b) *in the case of an LED array, equivalent brightness to a 15 watt filament bulb direction-indicator lamp.*

17.40.2

A direction-indicator lamp fitted to a low volume vehicle, other than one built or modified before January 1992, must, when in operation, emit light, both with and without the dipped-beam headlamp in operation, throughout the visibility angles specified in 17.41.1, that is clearly visible during conditions of clear daylight from a distance of 100 m (328').

17.41 Visibility (angles) of direction-indicator lamps

17.41.1

A direction-indicator lamp fitted to a low volume vehicle must, when operated, emit light that is visible within an angle of at least:

(a) *on a horizontal plane passing through the lamp:*

(i) *15 degrees above; and*

(ii) *15 degrees below;*

and

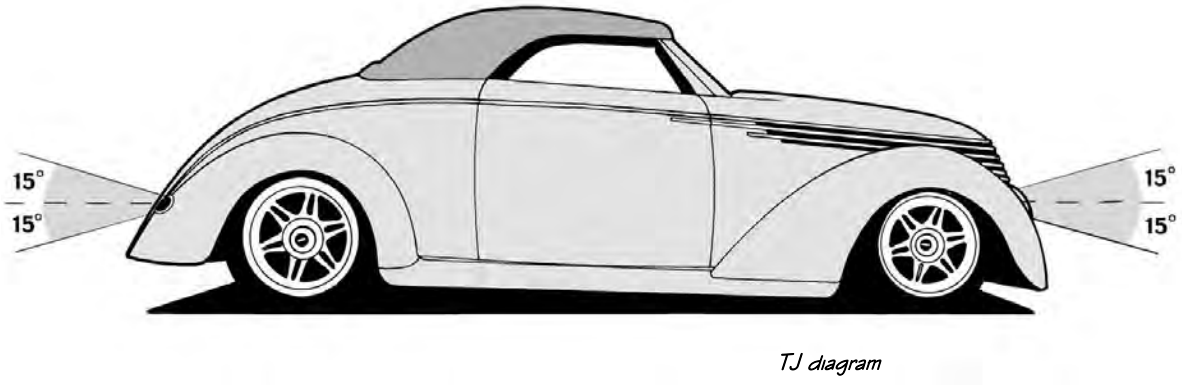
(b) *on a vertical plane that is parallel to the longitudinal centre-line of the vehicle, and passing through the lamp:*

(i) *45 degrees inboard; and*

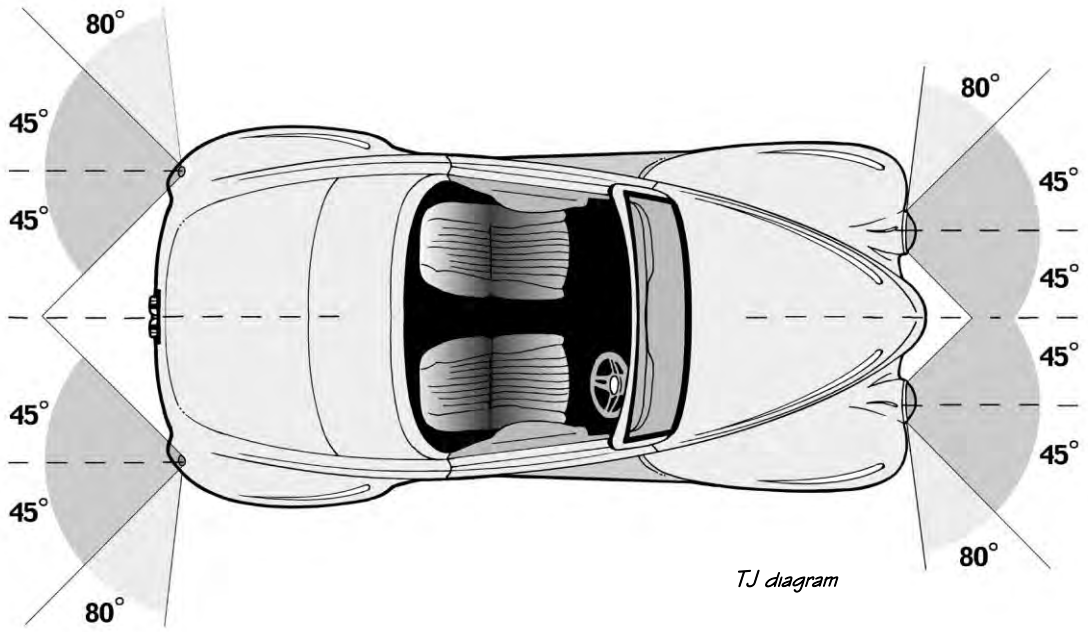
(ii) *80 degrees outboard, or in the case of a vehicle manufactured before 1970, or whose body replicates a vehicle manufactured before 1970, and the design of the body makes achieving an 80-degree outboard visibility angle impractical, 45 degrees. (see Diagram 17.2)*

17.41.1(b)(ii)

The 80 degree visibility requirement may be met by the fitment of an automotive side repeater lamp, which may use bulbs of less output than that specified in 17.40.1.



TJ diagram



TJ diagram

Diagram 17.2 Visibility angles for direction-indicators

A low volume vehicle built or modified before January 1992 is not required to have direction-indicators that comply with the requirements of Table 17.41.

17.42 Direction-indicator lamp sources

17.42.1

A filament bulb or LED array direction-indicator lamp fitted to a low volume vehicle, other than one built or modified before January 1992, must comply with any one or more of the approved standards specified for direction-indicator lamps listed in Table 17.2, by either incorporating the applicable standards markings on the direction-indicator lamp lens, or through other supplementary documented evidence. (see Table 17.2)

17.42.2

A filament bulb or LED array direction-indicator lamp fitted to a low volume vehicle, other than one built or modified before January 1992, that does not meet any one or more of the approved standards listed in Table 17.2, may be fitted provided that the lamp meets the requirements specified in Table 17.3.

A low volume vehicle built or modified before January 1992 is not required to have direction-indicator lamps that comply with an approved standard, or that meet the requirements of Table 17.3.

Forward-facing position-lamp (park) requirements

17.43 Number of forward-facing position-lamps

17.43.1

A low volume vehicle must be fitted with one pair of forward-facing position-lamps.

17.44 Colour of forward-facing position-lamps

17.44.1

When operated, a forward-facing position-lamp fitted to a low volume vehicle must emit diffuse light that is substantially white or amber.

17.45 Positioning of forward-facing position-lamps

17.45.1

A pair of forward-facing position-lamps fitted to a low volume vehicle must be:

(a) *positioned at the front of the vehicle; and*

(b) *symmetrically arranged.*

17.45.2

A pair of forward-facing position-lamps fitted to a low volume vehicle, other than one built or modified before January 1992, must be positioned at a width and height that is in accordance with the requirements specified in Table 17.1. (see Table 17.1)

17.46 Size of forward-facing position-lamps

17.46.1

A forward-facing position-lamp fitted to a low volume vehicle must incorporate a luminous lens surface area of not less than:

(a) *in the case of a filament bulb, 22 sq cm (3 ½ sq "); or*

(b) *in the case of an LED array, sufficient area to provide at least equivalent conspicuousness as a filament bulb specified in 17.46.1(a).*

17.47 Operation of forward-facing position-lamps

17.47.1

A forward-facing position-lamp fitted to a low volume vehicle may be either:

(a) *an individual item of lighting equipment; or*

(b) *a lamp that is incorporated as part of the headlamp assembly.*

17.48 Electrical connections for forward-facing position-lamps

17.48.1

A forward-facing position-lamp that is fitted to a low volume vehicle must automatically operate if the headlamps are activated.

17.48.2

Forward-facing position-lamps fitted to a low volume vehicle must operate simultaneously with the rearward-facing position-lamps, through a single and common activation.

17.49 Visibility (output) of forward-facing position-lamps

17.49.1

A forward-facing position-lamp fitted to a low volume vehicle must, when in operation, provide an output of not less than:

(a) *in the case of a filament bulb, 5 watts; or*

(b) *in the case of an LED array, equivalent brightness to a 5 watt filament bulb forward-facing position-lamp.*

17.49.2

A forward-facing position-lamp fitted to a low volume vehicle must emit light that is clearly visible from a distance of 200 m (656') during the hours of darkness.

17.50 Visibility (angles) of forward-facing position-lamps

17.50.1

A forward-facing position-lamp fitted to a low volume vehicle, other then one built or modified after January 1992, must, when operated, emit light that is visible within an angle of at least:

(a) *on a horizontal plane passing through the lamp:*

(i) *15 degrees above; and*

(ii) *15 degrees below;*

and

(b) *on a vertical plane that is parallel to the longitudinal centre-line of the vehicle, and passing through the lamp:*

(i) *45 degrees inboard; and*

(ii) *80 degrees outboard, or in the case of a vehicle manufactured before 1970, or whose body replicates a vehicle manufactured before 1970, and the design of the body makes achieving an 80-degree outboard visibility angle impractical, 45 degrees. (see Diagram 17.3)*

A low volume vehicle built or modified before January 1992 is not required to have forward-facing position-lamps that meet the requirements of 17.50.1.

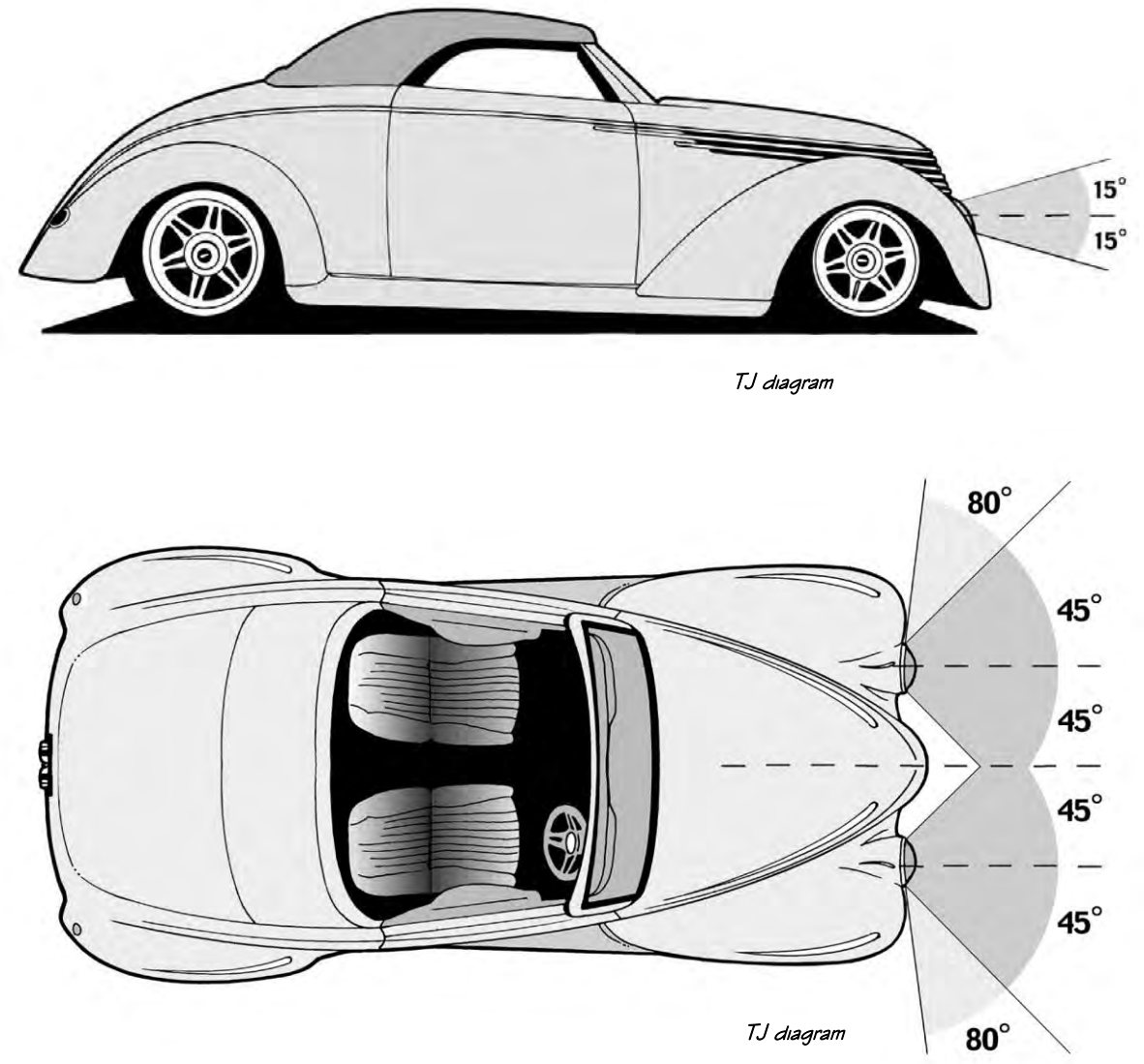


Diagram 17.3 Visibility angles for forward-facing position-lamps

17.51 Forward-facing position-lamp sources

17.51.1

A filament bulb or LED array forward-facing position-lamp fitted to a low volume vehicle, other than one built or modified before January 1992, must comply with any one or more of the approved standards specified for forward-facing position-lamps listed in Table 17.2, by either incorporating the applicable standards markings on the forward-facing position-lamp lens, or through other supplementary documented evidence. (see Table 17.2)

17.51.2

A filament bulb or LED array forward-facing position-lamp fitted to a low volume vehicle, other than one built or modified before January 1992, that does not meet any one or more of the approved standards listed in Table 17.2, may be fitted provided that the lamp meets the requirements specified in Table 17.3.

A low volume vehicle built or modified before January 1992 is not required to have forward-facing position-lamps that comply with an approved standard, or that meet the requirements of Table 17.3.

Rearward-facing position-lamp (tail) requirements

17.52 Number of rearward-facing position-lamps

17.52.1

A low volume vehicle must be fitted with one or two pairs of rearward-facing position-lamps.

See the 'Rearward-facing position-lamp exclusions' in 17.83 at the back of this chapter for those vehicles which may be fitted with a single rearward-facing-position lamp.

17.53 Colour of rearward-facing position-lamps

17.53.1

When operated, a rearward-facing position-lamp fitted to a low volume vehicle must emit diffuse light that is substantially red.

17.54 Positioning of rearward-facing position-lamps

17.54.1

A pair of rearward-facing position-lamps fitted to a low volume vehicle must be positioned at the rear of the vehicle, and symmetrically arranged.

17.54.2

A pair of rearward-facing position-lamps fitted to a low volume vehicle, other than one built or modified before January 1992, must be positioned at a width and height that is in accordance with the requirements specified in Table 17.1.

17.55 Size of rearward-facing position-lamps

17.55.1

A rearward-facing position-lamp fitted to a low volume vehicle must incorporate a luminous lens surface area of not less than:

(a) *in the case of a filament bulb, 22 sq cm (3 ½ sq "); or*

(b) *in the case of an LED array, sufficient area so as to provide at least equivalent conspicuousness as a filament bulb specified in 17.55.1(a).*

17.56 Electrical connections for rearward-facing position-lamps

17.56.1

A rearward-facing position-lamp that is fitted to a low volume vehicle must automatically operate if the headlamps are activated.

17.56.2

Rearward-facing position-lamps fitted to a low volume vehicle must operate simultaneously with the forward-facing position-lamps and the headlamps, through a single and common activation.

17.57 Visibility (output) of rearward-facing position-lamps

17.57.1

A rearward-facing position-lamp fitted to a low volume vehicle must, when in operation, provide an output of not less than:

(a) *in the case of a filament bulb, 5 watts; or*

(b) *in the case of an LED array, equivalent brightness to a 5 watt filament bulb rearward-facing position-lamp.*

17.57.2

A rearward-facing position-lamp fitted to a low volume vehicle must emit light that is clearly visible from a distance of 200 m (656') during the hours of darkness.

17.58 Visibility (angles) of rearward-facing position-lamps

17.58.1

A rearward-facing position-lamp fitted to a low volume vehicle, other than one built or modified before January 1992, must, when operated, emit light that is visible within an angle of at least:

(a) *on a horizontal plane passing through the lamp:*

(i) *15 degrees above; and*

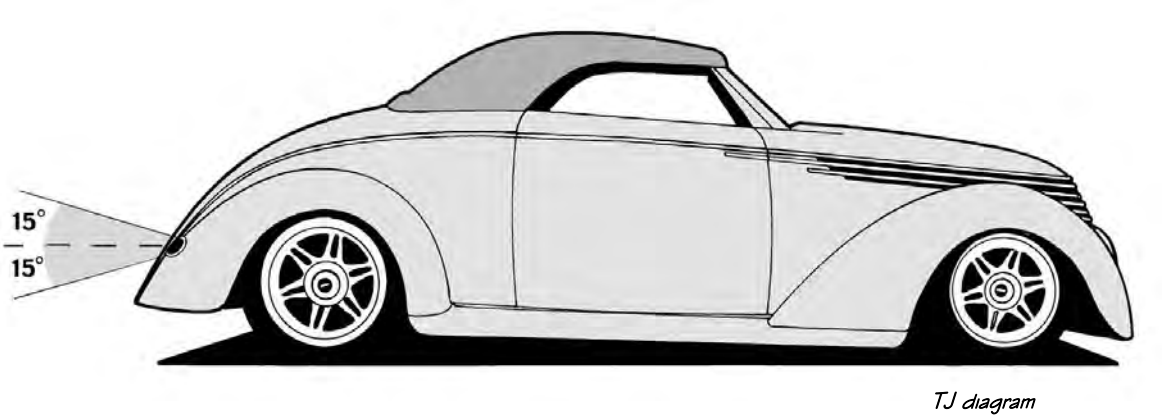
(ii) *15 degrees below;*

and

(b) *on a vertical plane that is parallel to the longitudinal centre-line of the vehicle, and passing through the lamp:*

(i) *45 degrees inboard; and*

(ii) *80 degrees outboard, or in the case of a vehicle manufactured before 1970, or whose body replicates a vehicle manufactured before 1970, and the design of the body makes achieving an 80-degree outboard visibility angle impractical, 45 degrees. (see Diagram 17.4)*



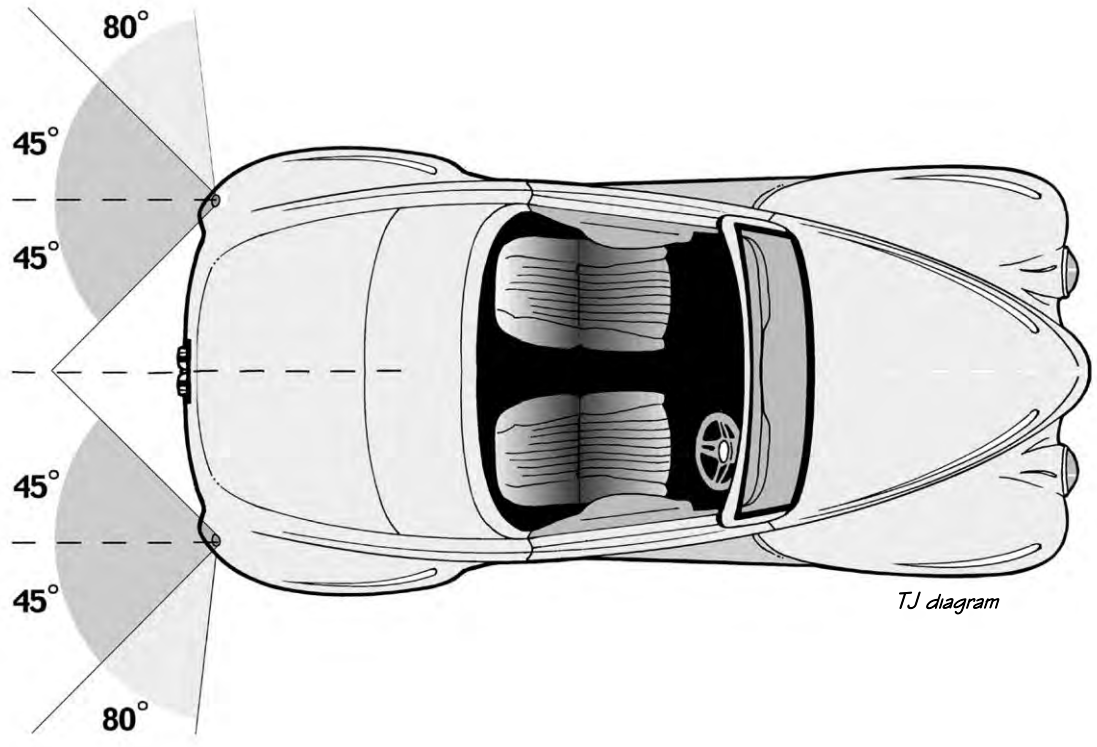


Diagram 17.4 Visibility angles for rearward-facing position-lamps

A low volume vehicle built or modified before January 1992 is not required to have rearward-facing position-lamps that meet the requirements of 17.58.1.

17.59 Rearward-facing position-lamp sources

17.59.1

A filament bulb or LED array rearward-facing position-lamp fitted to a low volume vehicle, other than one built or modified before January 1992, must comply with any one or more of the approved standards specified for rearward-facing position-lamps listed in Table 17.2, by either incorporating the applicable standards markings on the rearward-facing position-lamp lens, or through other supplementary documented evidence. (see Table 17.2)

17.59.2

A filament bulb or LED array rearward-facing position-lamp fitted to a low volume vehicle, other than one built or modified before January 1992, must comply with that does not meet any one or more of the approved standards listed in Table 17.2, may be fitted to a low volume vehicle provided that the lamp meets the requirements specified in Table 17.3.

A low volume vehicle built or modified before January 1992 is not required to have rearward-facing position-lamps that comply with an approved standard, or that meet the requirements of Table 17.3.

17.60 Blue-dot inserts for rearward-facing position-lamps

17.60.1

A rearward-facing position-lamp fitted to a low volume vehicle must not incorporate a blue-dot accessory insert within the lamp lens.

Rear registration-plate illumination-lamp requirements

17.61 Number of rear registration-plate illumination-lamps

17.61.1

A low volume vehicle must be fitted with at least one rear registration-plate illumination-lamp.

17.62 Colour of rear registration-plate illumination-lamps

17.62.1

When operated, a rear registration-plate illumination-lamp fitted to a low volume vehicle must emit diffuse light that is substantially white.

17.63 Positioning of rear registration-plate illumination-lamps

17.63.1

A rear registration-plate illumination-lamp that is fitted to a low volume vehicle must be positioned so as to illuminate the figures and letters of the rear registration-plate.

17.64 Electrical connections for rear registration-plate illumination-lamps

17.64.1

A rear registration-plate illumination-lamp fitted to a low volume vehicle must automatically operate if the headlamps are activated.

17.65 Visibility of rear registration-plate illumination-lamps

17.65.1

When operated, the light source of a rear registration-plate illumination-lamp fitted to a low volume vehicle must not be directly visible to the rear of the vehicle.

17.65.2

When operated, a rear registration-plate illumination-lamp fitted to a low volume vehicle must illuminate the figures and letters of a rear registration-plate so that they are visible during the hours of darkness from a distance of 20 m (66').

17.66 Rear registration-plate illumination-lamp sources

17.66.1

A filament bulb or LED array rear registration-plate illumination-lamp fitted to a low volume vehicle, other than one built or modified prior to January 1992, must comply with any one or more of the approved standards specified for registration-plate illumination-lamps listed in Table 17.2, by either incorporating the applicable standards markings on the rear registration-plate illumination-lamp lens, or through other supplementary documented evidence. (see Table 17.2)

17.66.2

A filament bulb or LED array rear registration-plate illumination-lamp fitted to a low volume vehicle, other than one built or modified prior to January 1992, that does not meet any one or more of the approved standards listed in Table 17.2, may be fitted provided that the lamp meets the requirements specified in Table 17.3.

A low volume vehicle built or modified before January 1992 is not required to have a rear registration-plate illumination-lamp that complies with an approved standard, or that meets the requirements of Table 17.3.

Retro-reflector lamp (reflector) requirements

17.67 Number of retro-reflectors

17.67.1

A low volume vehicle must be fitted with at least one pair of rearward-facing retro-reflectors.

17.68 Colour of retro-reflectors

17.68.1

A rearward-facing retro-reflector fitted to a low volume vehicle must reflect any white light shining on it as substantially red light.

17.68.2

A forward-facing retro-reflector, if fitted, to a low volume vehicle must reflect any white light shining on it as substantially white or amber light.

17.69 Positioning of retro-reflectors

17.69.1

A pair of rearward-facing retro-reflectors fitted to a low volume vehicle must be:

(a) *positioned at the rear of the vehicle; and*

(b) *symmetrically arranged.*

17.69.2

A pair of retro-reflectors fitted to a low volume vehicle must be positioned at a width and height that is in accordance with the requirements specified in Table 17.1.

17.70 Size of retro-reflectors

17.70.1

A retro-reflector fitted to a low volume vehicle must incorporate a luminous lens surface area of not less than 22 sq cm (3 ½ sq ").

17.70.2

A retro-reflector fitted to a low volume vehicle may be either:

(a) *an individual item of lighting equipment; or*

(b) *incorporated within the rearward-facing position-lamp.*

17.71 Visibility of retro-reflectors

17.71.1

A retro-reflector fitted to a low volume vehicle must reflect light to improve the visibility of the vehicle to other road users, without causing them undue dazzle or discomfort.

17.72 Retro-reflector sources

17.72.1

A retro-reflector fitted to a low volume vehicle, other than one built or modified before January 1992, must comply with any one or more of the approved standards specified for retro-reflectors listed in Table 17.2, by either incorporating the applicable standards markings on the retro-reflector, or through other supplementary documented evidence. (see Table 17.2)

A low volume vehicle built or modified before January 1992 is not required to have retro-reflectors that comply with an approved standard.

17.72.2

A retro-reflector that does not meet an approved standard specified in Table 17.2 may be fitted to a low volume vehicle provided it:

(a) *either:*

(i) *was fitted to a production vehicle as original equipment when the vehicle was manufactured; or*

(ii) *is manufactured from glass, by an aftermarket lamp manufacturer as a direct replacement for an original equipment lamp fitted to a production vehicle;*

and

(b) *the production vehicle for which the lamp is manufactured is a later model vehicle than the low volume vehicle to which the lamp is fitted, or in the case of a scratch-built low volume vehicle, the vehicle being replicated.*

17.72.2(b)

This requires that where a retro-reflector from a production vehicle is fitted, the retro-reflector must always be from a later-model vehicle, and not an older vehicle, so that the retro-reflector performance of the modified vehicle is always increased and not decreased, as a result of the fitment.

17.72.3

A retro-reflector that is custom-manufactured may be fitted to a low volume vehicle, provided that either:

(a) *the retro-reflector is:*

(i) *part of a retro-reflector, or lens that incorporates a retro-reflector, that was fitted as original equipment to a production vehicle; and*

(ii) *meets one or more of the approved standards specified in Table 17.2;*

or

(b) *in the case of a retro-reflector custom-manufactured from sheet material, documented evidence is provided to the LVV Certifier to substantiate that the optical properties and ultra-violet light resistance of the sheet material is acceptable.*

7.72.3(a)(i)

If a retro-reflector is custom-made from a part of an OE lamp from a production vehicle, and the custom-made retro-reflector does not incorporate the approved standards markings from the OE lens, the remainder of the OE lens from which the custom-made retro-reflector is cut should be retained and made available to the LVV Certifier in order to verify to the LVV Certifier the origin of the custom-made lens.

17.72.3(b)

Where 17.72.3(b) applies, LVVTA should be consulted to confirm the suitability of the material.

Optional lamp requirements

17.73 Cosmetic lamp requirements

17.73.1

A low volume vehicle that is fitted with cosmetic lamps must meet the applicable requirements of LVVTA LVV Standard 125-00 (Lighting Equipment).

17.73.1

'Cosmetic lamps' are, in effect, any lamp not covered in this chapter.

This LVV Standard is available free of charge from the LVVTA website, www.lvvta.org.nz

17.74 Interior lamps

17.74.1

A low volume vehicle is not required to be fitted with an interior lamp, however one or more interior lamps serving to light the interior of a low volume vehicle for the convenience of passengers may be fitted, in which case they must not, when in use whilst the vehicle is in motion:

(a) *adversely affect the driver's vision; or*

(b) *cause undue dazzle or discomfort to other road users.*

17.75 Daytime running-lamps

17.75.1

A low volume vehicle is not required to be fitted with daytime running-lamps, however one pair of daytime running-lamps may be fitted to the front of the vehicle, in which case they must:

(a) meet one or more of the approved standards specified for daytime running-lamps listed in Table 17.2; and

(b) *when operated, emit light that is substantially white or amber; and*

(c) *not operate when a front fog-lamp or headlamp is in use.*

17.76 Reversing-lamps

17.76.1

A low volume vehicle is not required to be fitted with reversing-lamps, however one or two reversing-lamps may be fitted to the rear of the vehicle, in which case they must:

(a) meet one or more of the approved standards specified for reversing-lamps listed in Table 17.2; and

(b) *emit light that is substantially white; and*

(c) *emit a diffuse light or a dipped beam of light; and*

(d) *be able to be operated only when either the reverse gear is engaged, or the headlamps are extinguished.*

17.77 Cornering-lamps

17.77.1

A low volume vehicle is not required to be fitted with cornering-lamps, however one pair of cornering-lamps may be fitted for use when cornering, provided that:

(a) *the cornering-lamps are fitted by a high volume vehicle manufacturer when the vehicle is manufactured; and*

(b) *when operated, the cornering-lamps emit light that is substantially white or amber; and*

(c) *the vehicle is not modified in a way that affects the performance of the cornering-lamps.*

17.78 Fog-lamps

17.78.1

A low volume vehicle is not required to be fitted with one or more fog-lamps, however, if fitted, fog-lamps must:

(a) meet one or more of the approved standards specified for fog-lamps listed in Table 17.2; and

(b) *comply with the technical requirements specified for fog-lamps in the New Zealand Transport Agency Vehicle Inspection Requirements Manual for In-Service Vehicles.*

17.78.1(b)

The NZTA Vehicle Inspection Requirements Manual is what the Warrant of Fitness issuers use, and the information contained within it can be obtained from an LVV Certifier.

17.78.2

A front fog-lamp fitted to a low volume vehicle may be covered by a readily removable protective cover when it is not in use.

17.79 Moveable spot-lamps

17.79.1

A low volume vehicle may be fitted with a moveable spot-lamp, provided that:

(a) *the vehicle to which the spot-lamp is fitted is a production vehicle manufactured before 1960; and*

(b) *the spot-lamp was a factory or aftermarket accessory available at the time of the vehicle's manufacture.*

17.80 Decorative hood ornament-lamps

17.80.1

A low-wattage decorative-lamp may be incorporated within a hood ornament fitted to a low volume vehicle, provided that:

(a) *the vehicle to which the hood ornament is fitted is a production vehicle; and*

(b) *the hood ornament was a factory or aftermarket accessory available at the time of the vehicle's manufacture.*

17.80.1

A low-wattage decorative hood ornament-lamp may only be fitted to a vehicle for which a valid Vintage Car Club of New Zealand 'Lighting Equipment Endorsement' is issued.

17.81 Towing-lamps

17.81.1

A low volume vehicle may be fitted with a roof-mounted blue-lens towing-lamp, provided that:

(a) *the vehicle to which the towing-lamp is fitted is a production vehicle manufactured prior to 1960; and*

(b) *the towing-lamp is not operational.*

17.81.1

A blue roof-mounted towing-lamp was a common new car dealer-installed accessory during the 1940s to 1960s, to signal to other motorists that a trailer was being towed.

Exclusions:

17.82 Motor-sport exclusions

17.82.1

A low volume vehicle that is issued with a valid LVV Authority Card issued by MotorSport New Zealand is not required to meet the requirements of 17.6.2, provided that:

(a) *the additional headlamps are used only in competition events that are closed to the motoring public; and*

(b) *the additional headlamps can be disconnected from the regulatory main-beam and dipped-beam headlamps by a circuit-breaker that is within easy reach of the driver.*

17.83 Single rearward-facing position-lamp and stop-lamp exclusions

17.83.1

A low volume vehicle is not required to meet the requirements of 17.8.1 and 17.52.1, and may be fitted with a single rearward-facing position-lamp and a single stop-lamp, positioned at, or to the right of, the longitudinal centreline of the vehicle, if the vehicle either:

(a) *is less than 1.5 m (5') in width; or*

(b) *was manufactured before 1 January 1978; and*

(i) *was originally equipped with only one rearward-facing position-lamp and one stop-lamp by the vehicle manufacturer; and*

(ii) *the vehicle's performance characteristics have not been substantially enhanced from its as-manufactured condition.*

17.84 Direction-indicator lamp exclusions

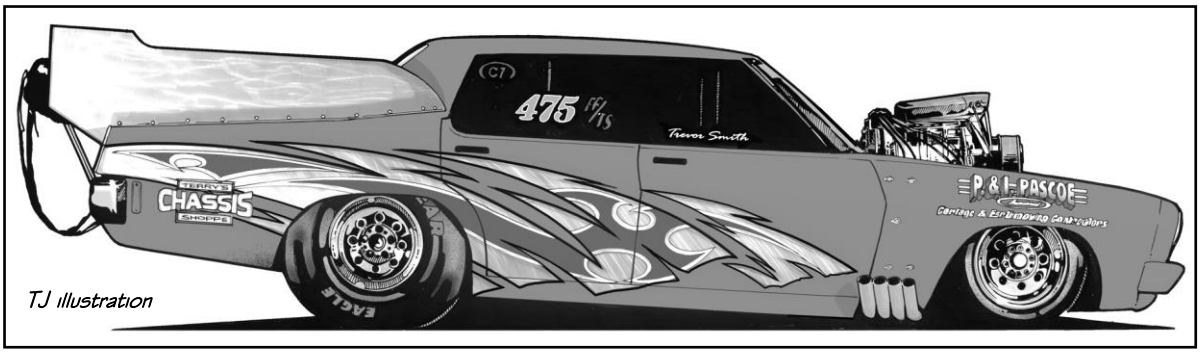
17.84.1

A low volume vehicle is not required to be fitted with direction-indicators, and therefore does not have to be fitted with direction-indicators as specified in 17.34.1 if the vehicle:

(a) *was manufactured before 1 January 1967; and*

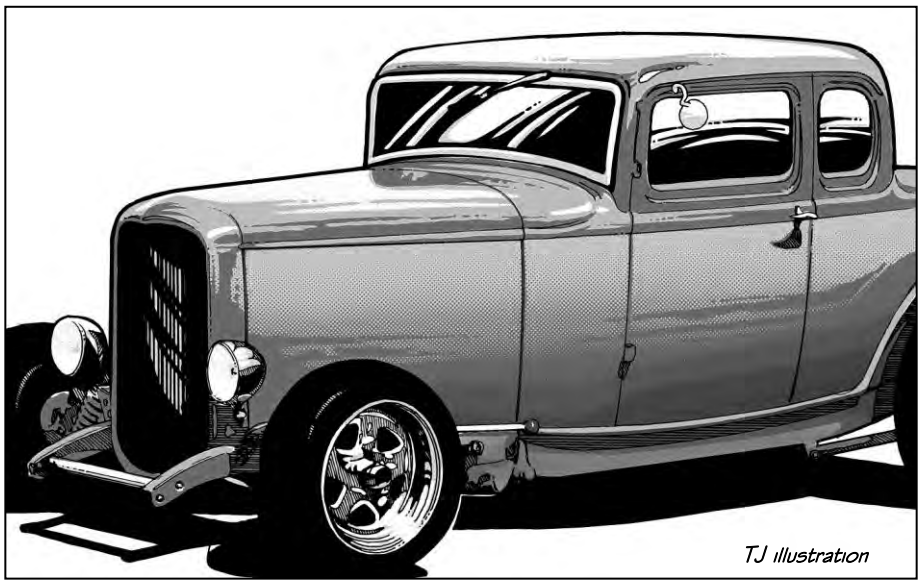
(b) *was not originally equipped with direction-indicators by the vehicle manufacturer; and*

(c) *the vehicle's performance characteristics have not been substantially enhanced from its as-manufactured condition.*



Chapter 18:

ATTACHMENT SYSTEMS



Chapter 18 Contents:

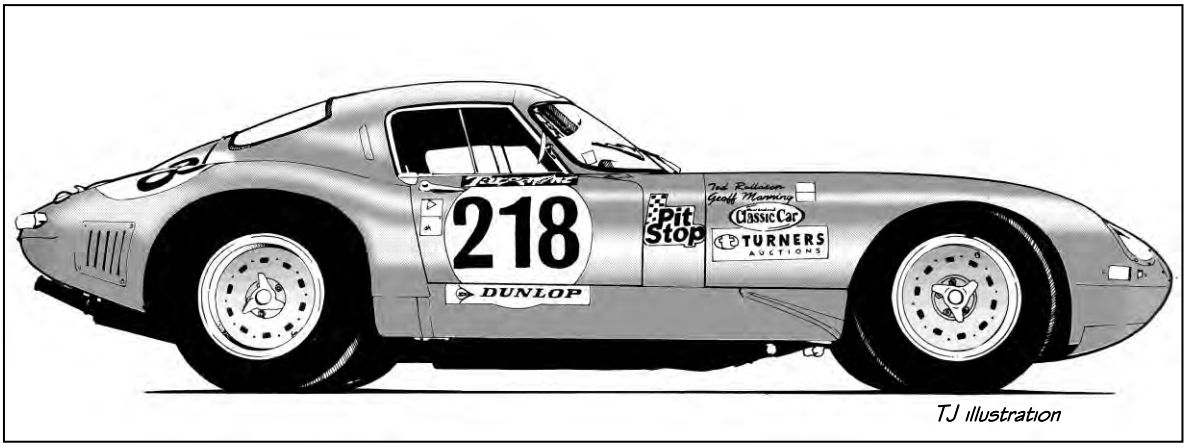
Technical requirements **Page 18-2**

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Key: (for full key details, refer to 'Chapter 2 – About this Manual')

Normal type: Provisions of the NZ Car Construction Manual for all vehicles
Normal type in shaded box: Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates
Italic type: *Extracts from any relevant LVVTA Low Volume Vehicle Standards*
Script type: Helpful hints, tips, explanations, clarifications, and interpretations
Shaded text & dotted vertical stroke in margin: Latest amendments since previous version



CHAPTER 18: ATTACHMENT SYSTEMS

Introduction:

The success of a vehicle's design and construction process depends largely on the many attachment processes used throughout the various components and systems within the vehicle. The correct types of attachment, in particular welding procedures and fastener details, are critical elements of a finished vehicle, and key contributors to its on-going safety and reliability. Usually, getting this part right is easy, as long as a builder or modifier has the right information before he or she goes out to buy the fasteners or arrange the welding. Note that where a production vehicle has its original fasteners in their original locations, the requirements in this chapter do not apply.

Technical requirements:

18.1 Adhesives and bonding agents

18.1.1

An adhesive or bonding agent, if used within a low volume vehicle, must be:

(a) supported by documented evidence to verify that the adhesive or bonding agent is of sufficient strength to be able to withstand the loading requirements to which it will be subjected throughout the life of the vehicle; and

(b) applied in accordance with the specifications and instructions of the adhesive or bonding agent manufacturer.

18.1.2

An adhesive or bonding agent, if used within a low volume vehicle, must not be used on any component that performs a critical function, attaches critical components, or attaches components that are under, or transmit high loadings.

18.1.1

The onus of proof is on the vehicle owner to provide whatever documented evidence is necessary to satisfy the LVV Certifier that the adhesive or bonding agent is sufficiently strong for its application.

18.1.2

'Critical' in this context, is a component, which, upon its failure, could lead to a loss of either braking control or steering control of the vehicle.

18.2 General fastener requirements

18.2.1

A fastener used in a safety-related application within a low volume vehicle must:

(a) be of an appropriate size and grade for the application; and

(b) be secured with a 'nyloc' nut, spring washer, split-pin, or other vibration-proof locking device; and

(c) be in good condition.

8.2.1

'Loctite' or other thread adhesives are not an approved vibration-proof locking device for the purpose of LVV certification, as such a system puts the LVV Certifier in a position where he would be 'approving' something he can't see.

18.2.2

A fastener used in a safety-related application within a low volume vehicle must not:

(a) have any head markings incorporated by the fastener manufacture removed; or

(b) in the case of a stainless steel fastener, be electroplated.

Normal single-grip spring washers should not be used against aluminium surfaces as they will gouge the aluminium – 'nylocs' or multi-grip washers should be used instead.

18.2.3

The threaded section of a fastener used in a safety-related application within a low volume vehicle must protrude through the outer end of the nut to which it attaches by not less than two full threads.

18.3 Locking device requirements

18.3.1

A 'nyloc' nut must not:

(a) be used to secure a fastener in a low volume vehicle, where there are extremely high temperatures within the immediate vicinity; or

(b) in the case of attachment of safety-related components or systems, be attached to a fastener in a low volume vehicle repeatedly.

18.3.1

'Nylocs' should not be used in such applications as brake caliper mounts, or brake rotor to hub mounts.

Like split pins, 'nylocs' are not designed to be used repeatedly; - if removed, they should be replaced by a new 'nyloc'.

18.3.2

A split-pin must not, in the case of attachment of safety-related components or systems, be used to secure a fastener in a low volume vehicle more than once.

18.4 Critical function fasteners (non-stainless steel)

18.4.1

A fastener used in a safety-related application within a low volume vehicle that is used to perform a critical function, attach critical components, or attach components that are under, or transmit, high loadings must, in addition to 18.2 and 18.3:

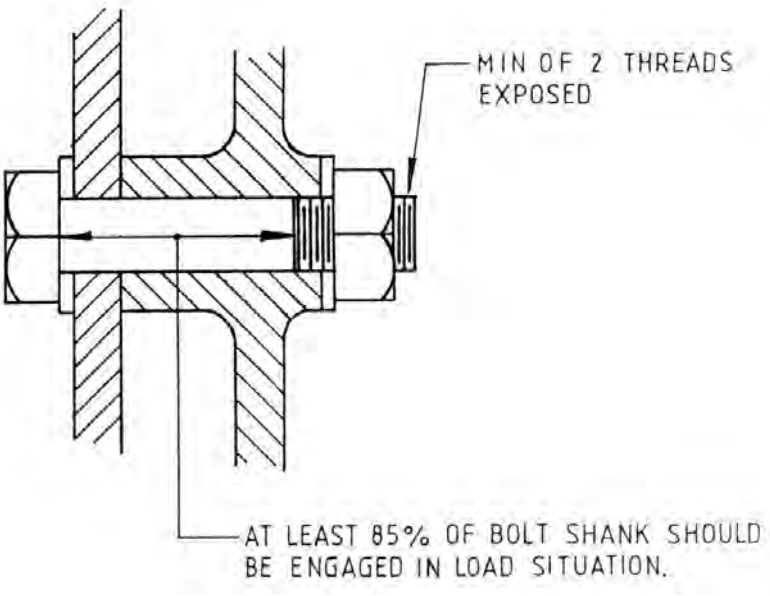
(a) have the correct shank area for the application (see Diagram 18.1); and

(b) have an equivalent tensile strength of between grade-8.8 metric (grade-5 imperial) and grade-10.9 metric (grade-8 imperial); and (see Table 18.1)

(c) if of a higher tensile strength than grade-8.8 metric (grade-5 imperial), not be electroplated unless: (see Table 18.1)

(i) documented evidence is provided to substantiate that a post-plating heat-treatment process has occurred in order to prevent hydrogen entrapment; or

(ii) the electroplating process is carried out as part of the manufacturing process by the fastener manufacturer, and documented evidence is provided to substantiate the origin of the fastener.



GW diagram

Diagram 18.1 Correct bolt-shank area

18.4.1

'Critical' in this context, is a component, which, upon its failure, could lead to a loss of either braking control or steering control of the vehicle, such as a suspension arm, steering shaft, brake pedal, or brake pedal pushrod.

Electroplating is any process that involves 'electrolysis', which includes zinc, cadmium, gold, and silver.

Ceramic coatings such as 'HPC' and 'Pro-coat' present no problems in this regard, are durable, and provide an excellent looking finish.

18.4.1(b)

Grades above 10.9 metric (grade-8 imperial) are not designed for cyclic loading and should not be used for critical applications where cyclic loading (such as steering, suspension, and brakes) is involved.

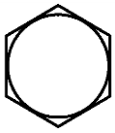
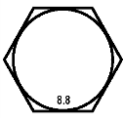
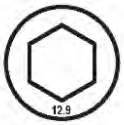
BOLT MARKING	IDENTIFICATION	BOLT MARKING	IDENTIFICATION
	Plain hex-head bolt, mild steel – not high-tensile		Hex-head bolt with six lines: grade-10.9 metric (grade-8 imperial) – 67 tons per sq in
	Okay to electroplate		**No electroplating** without post-plating heat treatment (unless bolt is supplied already plated by bolt manufacturer)
	Hex-head bolt with three lines: grade-8.8 metric (grade-5 Imperial) – 54 tons per sq in		Unmarked button-head internal-hex cap-screw: Very high-tensile – approx 84 tons per sq in
	Okay to electroplate		**No electroplating** without post-plating heat treatment (unless bolt is supplied already plated by bolt manufacturer)
	Hex-head bolt with 8.8 marking: grade-8.8 metric (grade-5 Imperial) – 54 tons per sq in		Marked button-head internal-hex cap-screw: Very high-tensile – approx 84 tons per sq in
	Okay to electroplate		**No electroplating** without post-plating heat treatment (unless bolt is supplied already plated by bolt manufacturer)

Table 18.1 Fastener (non-stainless steel) tensile strength identification guide table

18.5 Critical function fasteners (stainless steel)

18.5.1

A stainless steel fastener used in a safety-related application within a low volume vehicle that is used to perform a critical function, attach critical components, or attach components that are under, or transmit, high loadings must, in addition to 18.2 and 18.3:

(a) have the correct shank area for the application (see Diagram 18.1); and

(b) have an equivalent tensile strength of between grade-8.8 metric (grade-5 imperial) and grade-10.9 metric (grade-8 imperial). (see Table 18.2)

18.5.1

See Table 18.2 for stainless steel fastener tensile-strength identification.

'Critical' in this context, is a component, which, upon its failure, could lead to a loss of either braking control or steering control of the vehicle, such as a suspension arm, steering shaft, brake pedal, or brake pedal pushrod.

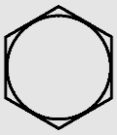
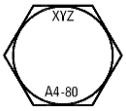
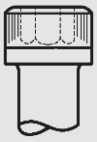
BOLT MARKING	IDENTIFICATION	BOLT MARKING	IDENTIFICATION
	Hex-head bolt with '304' or '316' marking: Equivalent or less than mild steel – 25-35 tons per sq in		Hex-head bolt with 'A2-70 marking: Almost equivalent to grade-5 – '70' denotes 700 MPa which equates to 46 tons per sq in
	Not equivalent to grade-5		**Equivalent to grade-5**
	Plain hex-head bolt with no marking: Equivalent or less than mild steel – 25-35 tons per sq in		Button-head internal-hex cap-screw with 'A2-70' marking: Almost equivalent to grade-5 – '70' denotes 700 MPa which equates to 46 tons per sq in
	Not equivalent to grade-5		**Equivalent to grade-5**
	Internal hex-head cap-screw with '304' or '316' marking: Equivalent or less than mild steel – 25-35 tons per sq in		Hex-head bolt with 'A4-80' marking: Equivalent to grade-5 – '80' denotes 800 MPa which equates to 52 tons per sq in
	Not equivalent to grade-5		**Equivalent to grade-5**
	Plain internal hex-head cap-screw with no marking: Equivalent or less than mild steel – 25-35 tons per sq in		Button-head internal-hex cap-screw with 'A4-80' marking: Equivalent to grade-5 – '80' denotes 800 MPa which equates to 52 tons per sq in
	Not equivalent to grade-5		**Equivalent to grade-5**

Table 18.2 Stainless steel fastener tensile strength identification guide table

18.6 Critical function fastener torque settings

18.6.1

A fastener used in a safety-related application within a low volume vehicle, that is used to perform a critical function, attach critical components, or attach components that are under, or transmit high loadings, must be tightened to the torque setting appropriate to the size, grade, and surface condition of the fastener. (see Table 18.3)

18.6.1

A light coating of oil should be applied prior to tightening (unless component or fastener manufacturer specifies otherwise), to enable the correct torque to be achieved.

SIZE	GRADE	SURFACE	TORQUE
6 mm (or 1/4 imperial)	8.8 metric (grade-5 imperial)	un-plated	10.5 Nm (7.7 ft lbs)
		plated	9.9 Nm (7.3 ft lbs)
	10.9 metric (grade-8 imperial)	un-plated	15 Nm (11 ft lbs)
		plated	14 Nm (10.3 ft lbs)
8 mm (or 5/16 imperial)	8.8 metric (grade-5 imperial)	un-plated	26 Nm (19 ft lbs)
		plated	24 Nm (17.7 ft lbs)
	10.9 metric (grade-8 imperial)	un-plated	36 Nm (26 ft lbs)
		plated	34 Nm (25 ft lbs)
10 mm (3/8 or 7/16 imperial)	8.8 metric (grade-5 imperial)	un-plated	51 Nm (37 ft lbs)
		plated	48 Nm (35 ft lbs)
	10.9 metric (grade-8 imperial)	un-plated	72 Nm (53 ft lbs)
		plated	67 Nm (49 ft lbs)
12 mm (or 1/2 imperial)	8.8 metric (grade-5 imperial)	un-plated	89 Nm (65 ft lbs)
		plated	83 Nm (61 ft lbs)
	10.9 metric (grade-8 imperial)	un-plated	125 Nm (92 ft lbs)
		plated	117 Nm (86.2 ft lbs)
14 mm (or 9/16 imperial)	8.8 metric (grade-5 imperial)	un-plated	141 Nm (103 ft lbs)
		plated	132 Nm (97 ft lbs)
	10.9 metric (grade-8 imperial)	un-plated	198 Nm (146 ft lbs)
		plated	185 Nm (136 ft lbs)
16 mm (or 5/8 imperial)	8.8 metric (grade-5 imperial)	un-plated	215 Nm (158 ft lbs)
		plated	200 Nm (147 ft lbs)
	10.9 metric (grade-8 imperial)	un-plated	305 Nm (224 ft lbs)
		plated	285 Nm (210 ft lbs)

Table 18.3 Fastener torque-setting guide table

18.7 General welding requirements

18.7

General welding requirements are basic requirements that apply to all structural or safety-related welding throughout a low volume vehicle.

18.7.1

Welding used in any structural or safety-related application may only be carried out within a low volume vehicle provided that:

(a) the welding is carried out by a person who either:

(i) holds a relevant current qualification or trade certification for the type of welding undertaken; or

(ii) has demonstrated to the Low Volume Vehicle Certifier, by application of an LVVTA-approved welding test procedure, a satisfactory level of competence in the method of welding undertaken;

and

(b) for the purpose of confirming compliance with 18.7.1(a), either:

(i) a report is supplied by the person who carries out the welding to verify that the requirements of 18.7.1(a)(i) have been met; or

(ii) the Low Volume Vehicle Certifier verifies that the requirements of 18.7.1(a)(ii) have been met.

Where a non-critical component within a low volume vehicle was modified or constructed before 1992, or where there is no way of confirming who carried out the welding, 18.7.1 does not apply, provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

18.7.2

Welding of any structural or safety-related areas incorporated within any chassis modification or construction or other component within a low volume vehicle must not:

(a) be ground other than for:

(i) light 'dressing' at the start and stop points of weld beads; or

(ii) achieving a radius at joins or external corners, provided that a weld depth of not less than the thickness of the parent material is maintained;

or

(b) be covered by any plastic filler or any other material that may have the effect of changing the visual appearance of the weld shape prior to being inspected.

Where a chassis or other component within a low volume vehicle was modified or constructed before 1992, 18.7.2 does not apply, provided that after thorough visual inspection, no fatigue cracking or fracturing is evident. Specific investigation for fatigue cracking or excessive grinding may be carried out, with removal of filler and paint if necessary to assist the inspection process.

18.7.1(a)(ii)

Builders can carry out their own chassis and other non-critical component welding even if they are not formally qualified, providing that the builder meets the requirements of a practical test applied by an LVV Certifier.

This test has been developed specifically to enable competent people to carry out their own structural welding if they so desire.

18.7.2

While strongly discouraged, 'smoothing' (via the use of paint prep or filler) of welds for show purposes can take place. The LVV Certifier in this case however, needs to carry out an inspection before the smoothing takes place, and furthermore, be satisfied that no grinding will occur after the inspection and prior to the smoothing process.

18.7.2(a)(ii)

This is to allow a radius to be provided where chassis C-section rails have been boxed.

18.9

See the 'Useful Information' section at the end of this chapter for information on welding castings and forgings.

18.8 Chassis welding requirements

18.8.1

In addition to 18.7, any welding carried out within a chassis modification or construction on a low volume vehicle, must be:

(a) in the case of a production or custom ladder chassis, by either:

(i) arc electrode; or

(ii) metal inert gas (MIG); or

(iii) tungsten inert gas (TIG);

or

(b) in the case of a production or custom space-frame chassis which incorporates chassis tubes which have a wall thickness of 2 mm (3/32") or less, by either:

(i) metal inert gas (MIG); or

(ii) tungsten inert gas (TIG); or

(iii) gas brazing; or

(iv) oxy-acetylene.

18.9 Critical function welding requirements

18.9.1

In addition to 18.7, any safety-related component within a low volume vehicle that is used to perform a critical function, or that is under, or transmits, high loadings, must not:

(a) be welded by any process other than tungsten inert gas (TIG); or

(b) have any weld:

(i) ground, linished, or smoothed in any way; or

(ii) covered by plastic filler or any other material that may have the effect of changing the visual appearance of the weld shape.

18.9.2

In addition to 18.7 and 18.9.1, the welding of any component within a low volume vehicle that is used to perform a critical function, must:

18.9.1

'Critical' in this context, is a component, which, upon its failure, could lead to a loss of either braking control or steering control of the vehicle, such as a suspension arm, steering intermediate shaft, brake pedal, or brake pedal pushrod.

18.9.1(b)

'Linish' means to finish or prepare by means of a high-speed belt-sanding process. Note that this clause does not preclude the minor 'dressing' by linishing if required as part of the NDT (non-destructive testing) process.

18.9.2(a)

The best NDT methods are x-ray, ultra-sonic, and magnetic-particle, because they are the types that not only look for surface cracking or fracturing, but can also identify poor weld fusion.

(a) be non-destructively tested, and comply with, as a minimum, Tables 6.1 or 6.2 of the AS/NZS 1554.1:2004 Standard, or an equivalent standard, as applicable to the method of weld examination undertaken, by a person holding not less than a current NDT Level 2 qualification in CBIP, ASNT, AINDT, or other equivalent certification; and

(b) be accompanied by a report supplied by the person who undertakes the non-destructive testing to verify that the requirements of 18.9.2(a) have been met, and that the component is considered to be free of defects.

18.9.2(a)

Magnetic-particle is considered the best all-round NDT method. Note however that because magnetic-particle will not work on aluminium or stainless steel, dye-penetrant should be used on aluminium and stainless steel components.

18.9.2(b)

Welds for critical items must be defect-free.

Exclusions:

No exclusions apply to this chapter.

Useful Information:

'G-force' in relation to fastener strength

A 'G' is something that most of us petrol-heads write off as being too complicated to properly understand, and not really all that important anyway. However, it is actually worth understanding. To be sure, it's a complicated thing from a correct scientific point of view, but what it's really all about is how things become heavier when certain forces are applied. Here's a hitch-hikers' guide to it:

If you sit in the passenger seat of a car while it's parked in the drive and cradle a 5 kg (11 lb) fire extinguisher in your arms, its weight is 5 kg, downwards. If your buddy hops in the driver's seat and drives your car (which happens to be a road-going circuit car with a big flash braking system) while you're holding the extinguisher, and does a full-on panic stop that generates 1 'g' of deceleration (Mum's grocery-getter might produce .6 to .7 of a 'g'), that extinguisher will still weigh 5kg downwards, but will now <u>also</u> weigh 5kg in the <u>forward</u> direction – you'd have to really hang on to it. If you were involved in a light crash (an easy get-out-and-walk-away job) which generated, say, 5 'g' deceleration, the extinguisher still weighs 5 kg (11 lbs) downwards, but now <u>also</u> weighs 25 kg (55 lbs) (5 kg weight x 5 'g') in the <u>forward</u> direction – you'd never be able to hold onto it.

20 'g' is generally considered to be about the limits of survivability for a sustained impact (you'll hear about much greater 'g' loads during an IndyCar crash, but that's only a peak load for a millisecond, and it depends on where the sensors are located. If the crash was a biggie, say 20 'g' (average for the duration of the crash as happens in a head-on), then that 5 kg (11 lb) extinguisher (in addition to still weighing 5 kg downwards), now becomes a 100 kg (220 lb) (5 kg x 20) forward-direction missile.

This is why seatbelt anchorages are such a big deal; if you weigh 100 kg (220 lbs), then in that bad crash, the seatbelt anchorages have to effectively hold over 2000 kg (4400 lb). Think of your gas tank – you figure the fastening system has got to be strong enough to support the weight of the small tank and the fuel that's in it, maybe 50 kg (110 lb), but in reality, you've got to think of your fastening system, not as holding something that weighs 50 kg, but something that could (in the event of a collision) weigh a ton.

F1 and IndyCars can generate more than 4 'g' in cornering (that's 4 times the braking force you'll experience in a NZ V8 Touring Car – in the sideways direction!) Top Fuel dragsters are generating more than 8 'g' of acceleration off the start-line, plus close to the same amount of deceleration under parachute deployment - which is why some of the old-timers are retiring from drag racing because of eye problems – the massive 'g' loads that their eyes have been subjected to over and over during years of popping the 'chute at Top Fuel speeds are literally trying to pull their eyeballs away from their stringy bits.

This is also a good reason to bring home that 396 and Turbo 400 for the next project on a trailer, and not in the back of your station wagon or van. But still do a good job of tying it down!

That's a very crude and unscientific explanation of the 'g' subject, and those with an engineering degree will pick at the terminology - but at least this way, us practical folk can all understand it.

Electroplating fasteners

During the acid cleaning and plating procedures that are carried out during the electroplating process, various chemical reactions take place within the item, which sets free hydrogen atoms, which dissolve into the steel. These atoms concentrate themselves into high stress areas like the head-to-shank corners, and thread corners at the shank end. This concentration of hydrogen atoms weakens the area that they settle in, and this weakening is what is known as 'hydrogen embrittlement'.

Tiny cracks can begin at these points, particularly after continued movement and loading, eventually leading to the failure of the component, which is known as a 'hydrogen embrittlement fracture'. There is a lot of evidence of this happening within the car hobby movement over the years as people have had high-tensile fasteners and other components electroplated. Actual examples seen include bolt heads popping off, shearing of bolt shanks under a load far less than that which the bolts are made to withstand, and even tubular suspension radius rods.

Hydrogen absorption and entrapment, and subsequent embrittlement, becomes more likely in higher tensile strength materials. The higher the strength of the steel, the higher the likelihood of electroplating causing a failure. Springs (such as trunk-lid springs) are a classic example – chrome them and they probably won't last a week!

Also, bear in mind that a fastener that does an important job should never be electroplated more than once, as the hydrogen embrittlement that is likely to occur during the process is cumulative.

The tensile strength cut-off point (where there is sufficient likelihood of absorption of hydrogen and subsequent component failure to justify the caution of plating items beyond that point) is 60 tons per square inch. This means that any fastener with a tensile strength of greater than grade-8.8 metric (grade-5 imperial) falls into the high-risk category, and must not be electroplated without evidence of the appropriate post-plating heat-treatment process to draw out the hydrogen from the component.

High-tensile fasteners which already feature silver or gold coloured zinc or cadmium plating or passivating off the shelf are generally considered acceptable if purchased from a reputable supplier. Be aware that there is some rubbishy stuff about – always purchase fasteners from a reputable engineering supplier or specialised fastener supplier.

Because of the poor quality passivated fasteners that are on the market, it's not really worth the risk of using them in a high-stress or critical application, unless there's a very good reason for wanting to do so.

Tensile strengths of imperial and metric fasteners

Below is a table (Table 18.4) that shows how an imperial fastener compares with a metric fastener in terms of tensile strength. One other thing this table highlights, is what a huge difference there is in strength between a low grade fastener like plain mild steel compared to, say, a grade-8 imperial. Most hobby car people know that a grade-8 imperial bolt is stronger than a mild steel bolt, but many wouldn't realise that the grade-8 is in fact 3 times stronger. The fasteners shown in shading are the common stainless steel types.

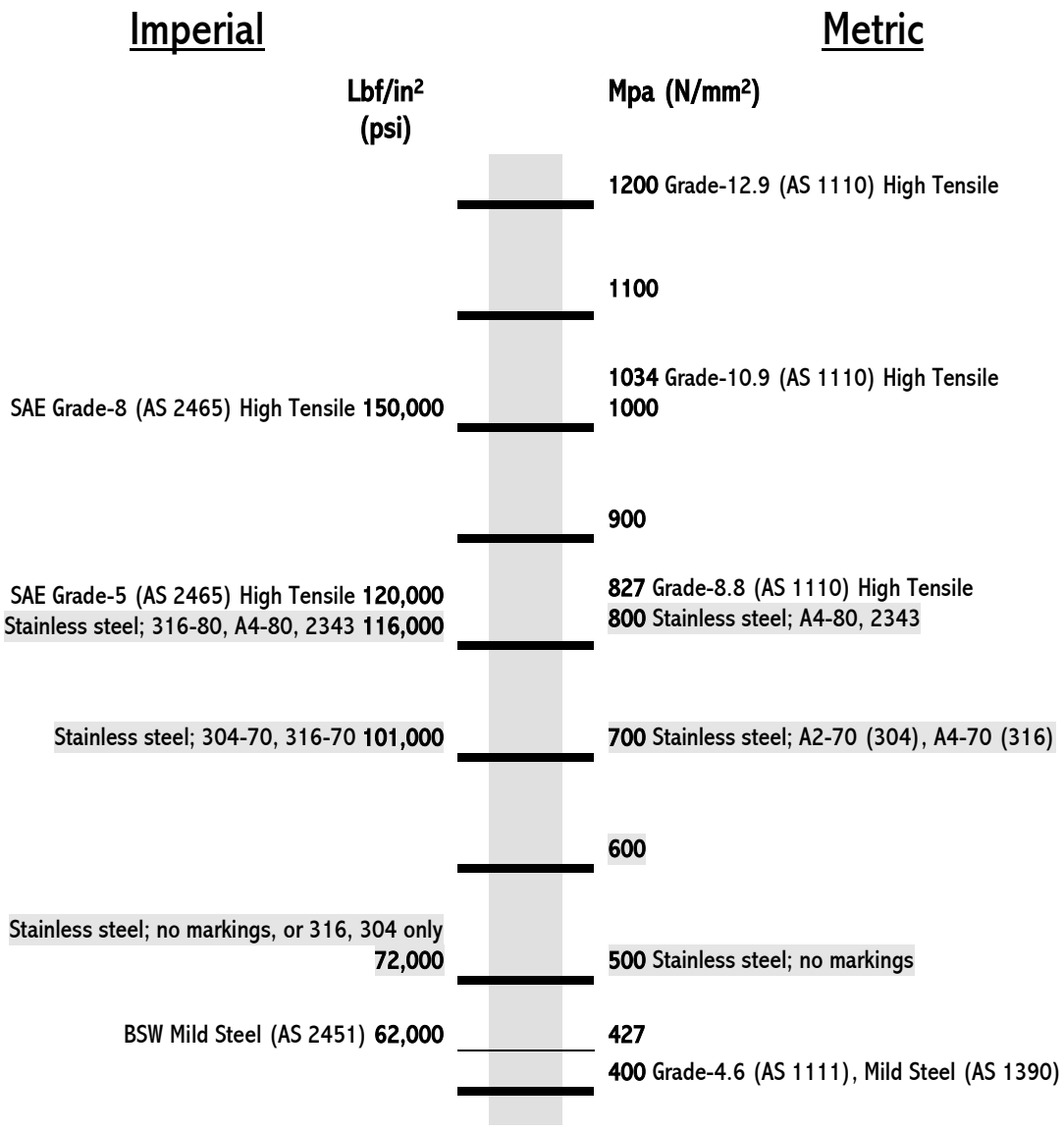


Table 18.4 Fastener tensile strength comparison guide table

Rivnuts

'Rivnuts' are an excellent new device, ideal for providing what is effectively a captured nut anywhere you want one. Their use however, should be restricted to non-critical components, as they are not designed to withstand high torque loadings. Use them for mounting the coil to the firewall, but not for anything big, or critical to the safety of the vehicle.

Stainless steel fasteners

Stainless steel fasteners look great, continue to look great for a long time, and are now easier than ever to source, so they're certainly the hot ticket for our hobby cars. However, care must be taken to get the right ones. There is a common perception that 'stainless steel bolts are strong'. This is far from the truth, and an easy trap for even older players to fall into. The majority of stainless steel fasteners in fact have less tensile strength than a grade-8.8 metric (grade-5 imperial) bolt, and many have even less tensile strength than a normal mild steel bolt.

What these bolts do have is excellent anti-corrosive qualities, so stainless steel bolts are ideal for the food, beverage, and marine industries, and those are in fact the applications that most stainless steel bolts are manufactured for – applications where strength is not required.

So the moral of this story is that most commonly available stainless steel bolts have tensile strengths well below a level acceptable for critical (high stress or load) automotive applications, and therefore can't be used in the important places in our hobby vehicles. Use Table 18.2 to ensure that the stainless steel fasteners you buy for the important jobs are in fact as strong as they need to be.

Another trick with stainless fasteners is that, generally speaking, most of them that do have the required load capabilities, are only available in metric threads. There are, of course, specialist companies that do provide imperial high load rating stainless steel bolts, but you might need to look beyond your local engineering supply store.

Used fasteners

In critical safety-related situations, such as attachment of steering or braking components, previously used bolts should be avoided due to the risk that they could have been over-tightened beyond their material strength limits, sometime in their past lives. This is especially the case with smaller fasteners, where over-tightening is much easier to do than most people realise.

Be careful – if you're using previously used bolts, you could in fact be installing into your pride and joy what may well be a hi-tensile fastener, but is in fact actually weaker than a plain mild steel one.

Welding of castings and forgings

A basic, but very important engineering principle threaded throughout the whole LVV certification process in New Zealand is that a forging or casting in a critical situation like suspension, steering, or brakes, must not be heated and bent, or welded, except in such highly controlled circumstances, that it is beyond the realm of the hobby car industry.

A forging or casting that is heated during a welding process must be re-heat treated afterwards, and this cannot be done correctly unless the exact molecular structure of the material of the forging or casting has been properly established beforehand by a metallurgist – which in turn enables the appropriate heat-treatment method to be established. This process is costly, and not practicable in one-off situations.

There is a very real risk of changes occurring within the molecular structure of a steel forging or casting when a welding process is applied, particularly if too much heat is applied during the heating or welding process, and the problems that this can create are often irreversible.

If anyone has a legitimate need to do this, it may be considered, but only after receiving written approval from the Technical Advisory Committee on a case-by-case basis.

The old practice of heating and bending, or welding, forgings or castings is for the history books; better components and machining processes are available now, to the extent that these practices can be left behind in the 'good old days' forever!

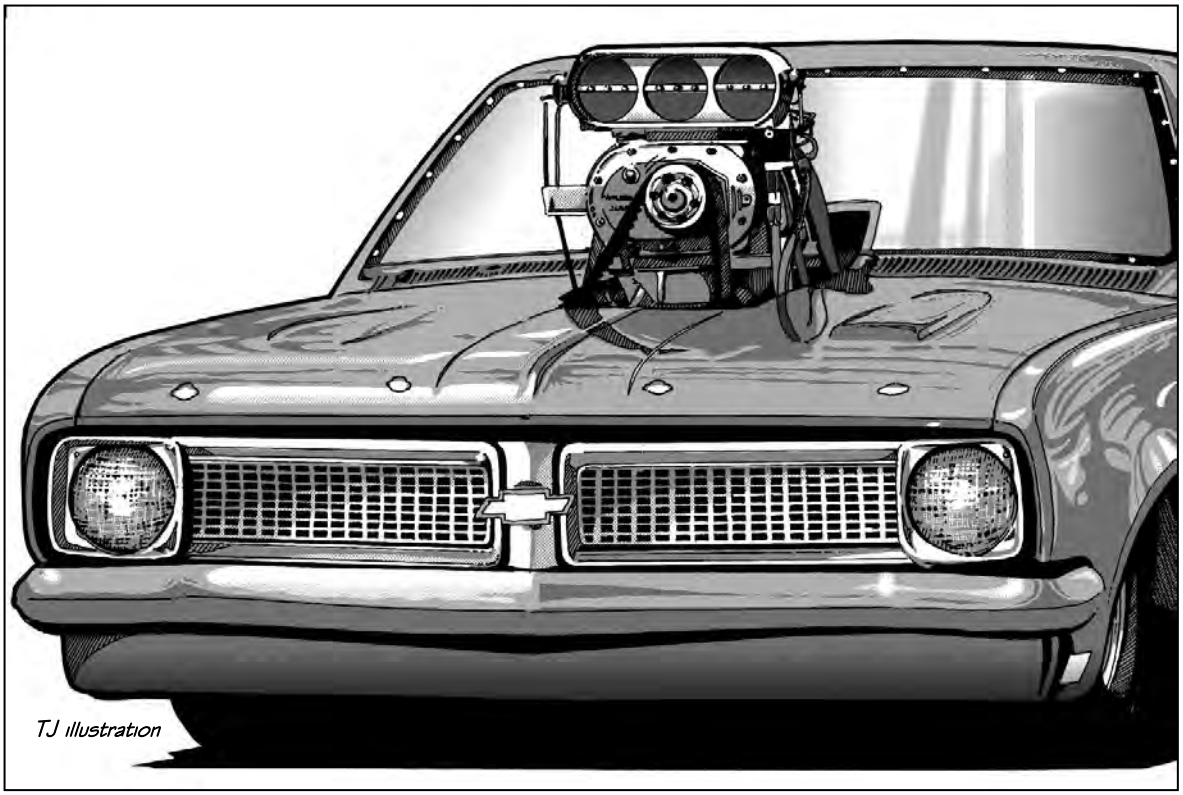
Torque settings

When tightening fasteners in a critical situation, like attaching braking or steering or suspension components, the correct torque setting should be applied to prevent either:

- insufficient clamping force against the fastener and nut, resulting in the fastener becoming loose over time; or
- a more common mistake; weakening of the fastener by over-tightening, resulting in a failure of the fastener, either immediately or at some later date.

It's amazing how many people, even experts, are guilty of over-tightening bolts. It's not until you start applying the correct torque settings to fasteners that you realise how tight they shouldn't be.

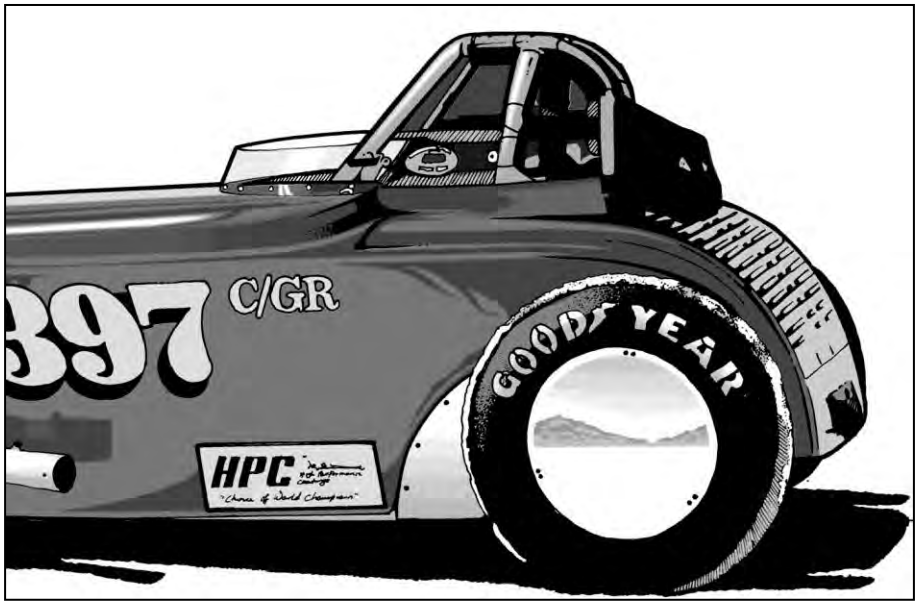
Using Table 18.3, which provides the approximate correct torque setting for common sizes and grades of bolts, is a good practice to get into. Note that this table is a guide only, as there is some variance between the correct torque loading for a fine thread and a coarse thread. The amount of lubrication applied affects the torque loading also.



TJ illustration

Chapter 19:

VEHICLE OPERATION



TJ illustration

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Key: (for full key details, refer to 'Chapter 2 – About this Manual')

Normal type: Provisions of the NZ Car Construction Manual for all vehicles
Normal type in shaded box: Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates
Italic type: *Extracts from any relevant LVVTA Low Volume Vehicle Standards*
Script type: Helpful hints, tips, explanations, clarifications, and interpretations
Shaded text & dotted vertical stroke in margin: Latest amendments since previous version



TJ illustration

CHAPTER 19: VEHICLE OPERATION

Introduction:

You've spent a small fortune and five years of your life getting to this point – it had better drive good! By following the principles in this Car Construction Manual, there's every chance that it will.

A general principle is embedded within this chapter that says no-one should build a car that no-one but the owner can drive, because it's a fact of life that others will drive your pride and joy, even if only at low volume vehicle certification time, or when you sell it. Therefore, the Low Volume Vehicle Certifier is going to have to satisfy himself when he road tests it, that your car is stable, safe, and user-friendly enough that any competent driver capable of driving a 'normal' car, could get in it and drive it safely if he or she had to. The LVV Certifier will be looking to ensure that your pride and joy has no bad habits, and that it is unlikely to inflict any nasty surprises on the driver.

The road-test process is a subjective one, which relies heavily on the feel and skill of the LVV Certifier. Fortunately, most of the top-level scratch-built authorised LVV Certifiers have spent most of their lives building and modifying cars of their own, friends, and club-mates, many of them have had some background in motor-racing of some sort, and they've all driven more modified and scratch-built vehicles than most people have ever seen, so their seat-of-the-pants style of analysis is worth its weight in chrome.

Interior:

19.1 Entry and exit

19.1.1

A low volume vehicle must be designed and constructed in such a way that any able-bodied person within a normal range of height is able to quickly and easily enter and exit the vehicle.

19.1.1

A low volume vehicle is not required to be fitted with conventional doors. However, the means of entry and exit that is provided must not necessitate contortionist-like activity.

19.1.2

All doors in a low volume vehicle must be able to be opened from the inside of the vehicle by a mechanical means.

19.1.1

In the case of a low volume vehicle which is designed in such a way as to possibly make entry and exit difficult, a Low Volume Vehicle Certifier may require, at his or her discretion, proof by way of a physical demonstration that an occupant can exit the vehicle, from being seated in a restrained position with the door closed, to standing outside the vehicle, within a maximum time of seven seconds.

19.2 Instrumentation & warning systems

19.2.1

A low volume vehicle must be fitted with a speedometer that:

(a) is accurate to within plus 10% to minus 2%; and

(b) can be easily read by the driver whilst seated in a normal driving position.

19.2.1(a)

It is common for speedometers to 'over-read' to provide a margin of error, however they should not 'under-read'.

19.2.2

A low volume vehicle must be fitted with an operative warning light that can be easily seen by the driver, whilst seated in a normal driving position, to indicate to the driver the operation of:

(a) if fitted, the high-beam lamps; and

(b) if fitted, the manual traction-control system; and

(c) if fitted, the roll-control or line-lock system.

19.2.1 & 19.2.2

This can be difficult to achieve sometimes, however any person within a normal height range should be able to see the speedometer and warning lights with a minimal amount of body or head movement.

19.2.3

A low volume vehicle must be fitted with a visual or audible method of informing the driver that the direction-indicators are in operation.

19.2.4

A low volume vehicle must be fitted with a horn that:

(a) is within easy reach of the driver when seated in a normal driving position; and

(b) can be heard under normal driving conditions from a distance of not less than 100 metres (109 yards).

19.3 Inhibitor switch

19.3.1

A low volume vehicle fitted with an automatic transmission must incorporate an operative inhibitor switch, so as to prevent the vehicle from being able to be started in any gear other than neutral or park.

19.4 Ergonomics

19.4.1

All hand and foot controls within a low volume vehicle must operate in such a way as to provide a natural and comfortable relationship with each other, and with the seating position of the driver.

A low volume vehicle that was built before 1992 is not required to comply with 19.4.1, provided that the vehicle can be safely operated.

19.4.1

There's no need to have an ergonomically-retarded car.

When setting up the interior of your project car, use the dimensions between key components like the seat, pedals, steering wheel, shifter, etc from modern production vehicles. Particularly with late-model vehicles, no matter where in the world they have been manufactured, these critical dimensions will be very similar. Understanding this, and transposing those key dimensions will enable you to achieve a safe and comfortable driving position.

19.4.2

All safety-related operating systems within a low volume vehicle must be able to be reached, and operated or adjusted, by a driver within an average range of height, whilst in the normal seated position, including:

(a) the gear-lever; and

(b) the driver's seatbelt; and

(c) the rear-view mirror; and

(d) the horn; and

(e) the light controls; and

(f) the indicators; and

(g) the windscreen wiping and washing controls.

19.4.3

A seat in a low volume vehicle that does not have adjustment in the fore and aft plane, must be positioned in such a way that any driver within an average range of height:

(a) can comfortably reach all primary controls so as to be able to safely operate the vehicle; and

(b) maintains sufficient clearance between the dash and steering wheel, and his or her knees.

19.4.4

A steering wheel in a low volume vehicle must be positioned in such a way that a comfortable driving position is achieved, and centrally in relation to the seat.

A low volume vehicle that was built before 1992 is not required to comply with 19.4.4, provided that the vehicle can be safely operated.

19.4.4

The position of the steering wheel and driver's seat should not cause the driver to be positioned hard against the side of the vehicle.

19.5 Pedals

19.5.1

Foot pedals in a low volume vehicle must:

(a) be within easy reach of the driver whilst seated in a normal driving position; and

(b) be sufficiently spaced to allow the pedals to be safely operated; and

(c) operate freely and smoothly.

19.5.1

It is recognised that in some circumstances, such as old-style cars with manual transmissions, shoes may need to be removed.

19.5.2

An accelerator pedal in a low volume vehicle must be provided with sufficient return spring tension to ensure that the throttle closes quickly and firmly upon accelerator pedal release.

19.5.3

A low volume vehicle fitted with a nitrous oxide system must incorporate a fail-safe arming system to prevent unintentional activation of the system.

19.5.3

This means that a manual arming switch must be activated before the nitrous system's momentary switch can operate.

Driving assessment:

19.6 Chassis

19.6.1

The chassis or body structure in a low volume vehicle must transmit to the driver a feeling of stiffness and rigidity during all types of vehicle operation, and over all types of road surfaces.

19.7 Suspension

19.7.1

A low volume vehicle must be fitted with shock absorbers that are effective and in good condition.

19.7.1

One shock absorber cycle after rebound is considered to be acceptable.

19.7.2

A low volume vehicle must maintain satisfactory stability during cornering, slalom-type turning, and during a combination of braking and turning, including over uneven road surfaces.

19.7.3

The suspension system in a low volume vehicle must:

(a) exhibit no scraping, binding, or contact between the wheel and tyre assembly, and any part of the vehicle structure or body panels during normal vehicle operation; and

(b) provide the vehicle with a well controlled ride on uneven surfaces.

19.7.4

The suspension system in a low volume vehicle must be designed in such a way that there is no contact between the suspension bump-stops, and the vehicle chassis, body, or suspension components, during normal vehicle operation.

19.7.5

A modified production low volume vehicle with lowered suspension may be inspected and tested at the discretion of the Low Volume Vehicle Certifier in a condition of simulated occupant weight and load, on the basis of 80 kg (176 lb) placed and secured in each seating position.

19.8 Air and hydraulic suspension

19.8

See 'Chapter 6 – Suspension Systems' for more information on correct airbag or hydraulic suspension system operation.

19.8.1

An airbag or hydraulic suspension system in a low volume vehicle must be designed and installed in such a way that, in the case of a system that can be adjusted whilst the vehicle is in motion:

(a) the vehicle automatically reverts back to its approved and specified ride-height when the speed of the vehicle exceeds 20 kph (12 mph); and

(b) the suspension cannot be altered or tampered with when the speed of the vehicle exceeds 20 kph (12 mph).

19.9 Steering

19.9.1

The steering system in a modified production low volume vehicle with modified suspension must steer in a manner which preserves not less than the quality of steering control that could be reasonably expected when the vehicle was originally manufactured.

19.9.2

The steering system in a scratch-built low volume vehicle must perform in a manner that gives a quality of steering control not less than that which could be expected from a production vehicle using components and systems having similar technology, taking into account the low volume vehicle's age, style, and intended purpose.

19.9.3

The steering system in a low volume vehicle must enable the driver to steer the vehicle at all normal vehicle operating speeds without applying excessive steering effort to the steering wheel.

19.9.3

It is recognised that some manual-steer vehicles will have heavy steering at parking speeds.

19.9.4

While being driven at normal road speeds, over a range of smooth, rough, undulating, and uneven road surfaces, the steering system in a low volume vehicle must provide to the driver good steering control, including:

(a) progressive and positive feel; and

(b) sufficient directional stability throughout all normal speeds, and over varying road surfaces, so as to enable relaxed driving; and

19.9.4(b)

The vehicle should continue to steer straight ahead if the grip on the steering wheel is relaxed, without any tendency to 'pull' in either direction, other than allowing for road camber.

(c) immediate and positive self-centering tendency after steering inputs, during both accelerating and neutral throttle conditions; and

(d) immediate and easy controllability when encountering direction change as a result of road camber changes or surface irregularities.

19.9.5

While being driven at normal road speeds, over a range of smooth, rough, undulating, and uneven road surfaces, the steering system in a low volume vehicle must not exhibit:

(a) any tendency to change direction upon suspension compression or extension; or

19.9.5(a)

This is the end result of 'bump-steer', and the LVV Certifier will be looking very hard for any signs of this dangerous characteristic.

(b) any tendency to change direction during light, medium, or hard braking; or

(c) any apparent excessive under-steer or over-steer tendencies during constant radius cornering, including when encountering mid-corner bump disturbances; or

(d) kick-back through the steering wheel during turn-in and turn-out; or

(e) any tendency to climb the road camber toward the opposing lane; or

(f) any excessive pitch movement; or

(g) any unpredictable steering tendencies or characteristics.

19.9.5(e)

Some mild tendency toward following the direction of the road camber is acceptable.

19.9.6

The steering system in a low volume vehicle must incorporate a lock that enables the vehicle to achieve a turning circle of not more than a 25 metre (82 feet) diameter.

19.10 Braking

19.10.1

A brake pedal in a low volume vehicle must maintain constant hydraulic line pressure while braking force is applied to the pedal.

19.10.2

A braking system fitted to a low volume vehicle must be able to be operated with a minimum of physical effort being applied in order to achieve reasonable braking force, and must enable:

(a) *braking effect to occur with a pedal force of not more than 6.6 kg (15 lb); and*

(b) *maximum braking effect to be achieved with a pedal force of not more than 68 kg (150 lb).*

19.10.2(b)

68 kg (150 lb) is approximately the amount of pedal pressure that a lightly built person could apply in an emergency.

19.10.3

A park-brake application and release mechanism fitted to a low volume vehicle must be within easy reach of the driver whilst seated in a normal driving position.

19.11 Brake stability test

19.11.1

Prior to commencing the cyclic brake fade-resistance test, a low volume vehicle must, when tested on a hard level road surface that is free of loose material, and with minimal camber, from a speed of 60 kph (37 mph), exhibit:

(a) *stability during the braking with no tendency to weave or swerve from the chosen line; and*

(b) *during smooth progressive pressure on the brake pedal, correspondingly smooth increase in braking force at the wheels; and*

(c) *no vibration felt through the brake pedal, steering wheel, or vehicle body; and*

(d) *no significant loss of adhesion, and no premature lock-up at either end of the vehicle; and*

(e) *no imbalance between the braking performance on the two sides of the vehicle; and*

(f) *no tendency to grab at any time throughout the test process.*

19.12 Cyclic brake fade-resistance test

19.12.1

A low volume vehicle must meet the applicable following brake test requirements, conducted on a hard level road surface that is free of loose material, and with minimal camber, without the deliberate aid of engine compression:

(a) *a modified production low volume vehicle which has attained an increase in engine power output from the original vehicle manufacturer's specifications of between 20% and 50%, or has any modifications to the service brake system, or has any modifications which result in a change in or relocation of weight or centre of gravity, must achieve:*

(i) *3 consecutive cycles from 100 kph (62 mph) to standstill each at an average deceleration of not less than 0.65G; and*

(ii) *within a total time of 2 minutes from the start of the first cycle to the completion of the third cycle;*

19.12.1(a)(i)

0.65G from 100 kph (62 mph) to 0 kph is equal to 4.4 seconds from 100 kph to 0 kph.

or

(b) *a scratch-built low volume vehicle, or a modified production low volume vehicle which has attained an increase in engine power output from the original vehicle manufacturer's specifications of more than 50%, must achieve:*

(i) *5 consecutive cycles from 100 kph (62 mph) to standstill each at an average deceleration of not less than 0.65G; and*

(ii) *within a total time of 3 minutes from the start of the first cycle to the completion of the fifth cycle.*

19.12.1(b)(i)

0.65G from 100 kph (62 mph) to 0 kph is equal to 4.4 seconds from 100 kph to 0 kph.

19.12.2

A low volume vehicle tested in accordance with 19.12.1(a) must be re-tested against the requirements specified in 19.12.1(b), if the vehicle either:

(a) *exhibits during the test any significant brake-fade between cycles; or*

(b) *has, in the opinion of the LVV Certifier, braking componentry which may not be of sufficient durability relative to the performance potential or mass of the vehicle.*

19.12.3

During the brake-testing process specified in 19.12.1, there must be:

(a) *stability maintained during the braking, with no tendency to weave or swerve from the chosen line; and*

(b) *during smooth progressive pressure on the brake pedal, a correspondingly smooth increase in braking force at the wheels; and*

(c) *no significant increase in the amount of force applied to the pedal between the first and the last cycle in order to achieve the same amount of braking efficiency; and*

(d) *no vibration felt through the brake pedal, steering wheel, or vehicle body; and*

(e) *no significant loss of adhesion, and no premature lock-up at either end of the vehicle; and*

(f) *no imbalance between the braking performance on the two sides of the vehicle; and*

(g) *no tendency to grab at any time throughout the test process.*

19.12.3

Some smoke and smell being emitted from the braking system during the brake-test process is quite normal.

19.12.3(e)

Any wheel 'lock-up' must occur as a pair – meaning if there is lock-up, both wheels on the same axle must lock together. It is better to have the front lock-up before the rear locks-up, rather than the other way around.

19.13 General requirements

19.13.1

A low volume vehicle must be able to be safely driven on the road by any person:

(a) within an average range of height; and

(b) of average driving ability.

19.13.2

The tyres fitted to a low volume vehicle must not exhibit any significant signs of scuffing, feathering, uneven or abnormal wear.

19.13.3

A differential in a low volume vehicle, except in the case of a vehicle that has been issued with a valid LVV Authority Card, must not incorporate a spool, or locked gears.

Exclusions:

19.14 Slow vehicle braking exclusions

19.14.1

A low volume vehicle that, during the process of conducting the service brake performance test is not able to readily attain a speed of 100 kph (62 mph), is not required to meet the 100 kph (62 mph) requirement specified in 19.12.1, and instead must meet 0.6G from whatever speed the vehicle is able to practicably achieve for the purpose of the tests.

19.14.1

0.6G from 90 kph (56 mph) to 0 kph is equal to 3.8 seconds, and .6G from 80 kph (50 mph) to 0 kph is equal to 3.4 seconds.

19.15 Wet road braking exclusions

19.15.1

A low volume vehicle that is required to be tested to 0.65G, but which due to a wet or slippery road surface at the time of testing may cause the testing process to be unsafe, can at the discretion of the LVV certifier be tested to 0.55G.

19.15.1

0.55G from 100 kph (62 mph) to 0 kph is equal to 4.8 seconds.

19.16 Old–style vehicle braking exclusions

19.16.1

A low volume vehicle that is constructed primarily from components sourced from production vehicles manufactured before 1929, is not required to meet the requirements specified in 19.10 to 19.12, provided that the vehicle can stop within a distance of 7 metres (23 feet) from a speed of 30 kph (19 mph).

19.16.2

A low volume vehicle that is constructed entirely from components sourced from production vehicles manufactured before 1952 and is fitted with a mechanical or rod braking system, as provided for in 8.18 of 'Chapter 8 – Braking Systems', is not required to meet the requirements specified in 19.10 to 19.12 provided that the vehicle can stop within a distance of 7 metres (23 feet) from a speed of 30 kph (19 mph).

Useful Information:

Bedding-in new brake pads

When new brake pads are fitted, which will be the case for nearly all new scratch-built vehicles, a bedding-in process will need to be applied to the system, in order to achieve optimum performance throughout the life of the pads.

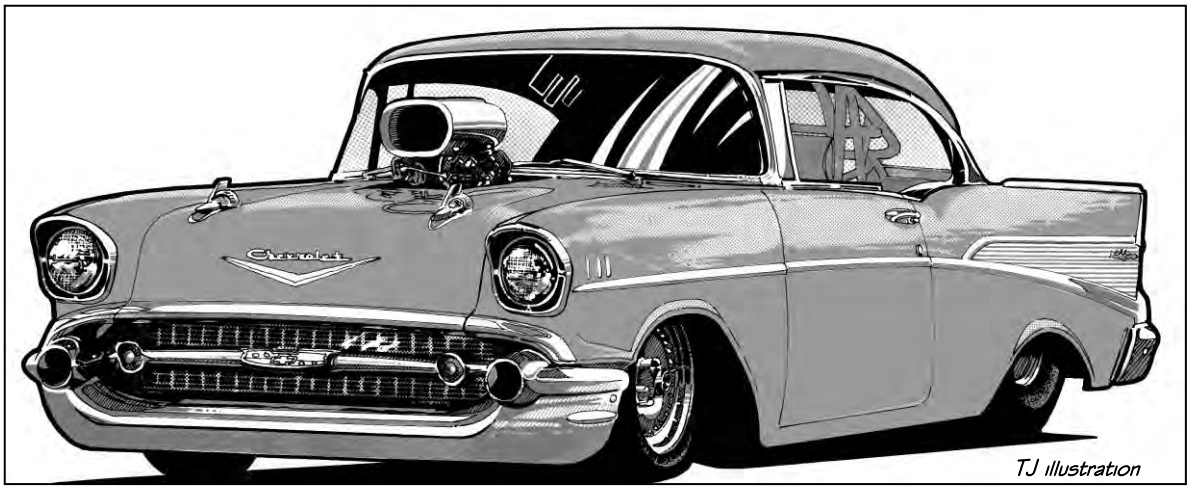
Maximising braking efficiency

To maximise the likelihood of having your vehicle drive well, and therefore perform well during the road test for the LVV Certifier, consider doing the following:

- fitting top-quality high-performance brake pads (this can help massively with the brake-fade testing) ; and
- have a full wheel alignment carried out; and
- check that the tyres are correctly inflated.

If there are no specific bedding-in instructions available from the brake pad supplier, a basic bedding-in process, as follows, will generally do:

- test brakes gently from 20kph (12 mph) and 30kph (19 mph) for function, and proceed if the brakes apply evenly, and feel good;
- in quick succession, make a minimum of 4 medium to hard applications of the brakes from between 50kph (31 mph) to 60kph (37 mph), each time almost to a stop, followed by two hard applications from 100kph (62 mph), avoiding lock-up (a bit of brake smoke and stink toward the end of this process is quite normal);
- continue to drive the vehicle at normal speeds making minimal use of the brakes for 4 to 5 minutes.



Terms and Definitions

A-arm	means the top and bottom control arms in an independent suspension system, also known as wishbone arms.
Ackerman-angle	means a steering geometry principle that ensures that the inside front wheel prescribes a tighter radius than the outside front wheel in any turning situation, in order to prevent scrubbing of the tyres.
Aftermarket	means a manufacturer or supplier, other than a high volume motor vehicle manufacturer, who produces components or systems on a production-run basis for the mass-market.
Annealed	means a process used to render steel less brittle than in its original as-manufactured state, by allowing the material to cool very gradually from a high heat.
A-Pillar	means the forward-most pillars that support the windscreen and the front of the roof, and from which the front doors are usually hinged.
Aramid-ply	is the generic name for what we know as 'Kevlar'.
A-zone	means the area within a passenger compartment that is inside an arc swung in a forward direction from the h-point using either an LVVTA body frame, or an LVVTA H-point template with the seat in its mid-point position if adjustable, from the seatback in a normal driving position to the seat base, of ▪ where web-clamp retractor lap and diagonal or four-point harness seatbelts are fitted, a 700 mm (28") radius; or ▪ where seatbelts of types other than stated above are fitted, a 900 mm (37") radius; and ▪ 160 mm (6 ½") on either side of the longitudinal centerline of each seating position.
Baffling	means, in the context of this manual, a barrier to prevent splashing and surging of fuel in a fuel tank, during braking, accelerating, and cornering.
Ball flare	means a type of brake pipe end-flare that has a circular shape, rather than the more commonly used 'double-flare', that is shaped like an inverted cone.
Beaming	means, in relation to a chassis or floor-pan, bending loads of a type that could result in sagging on the horizontal plane throughout the length of the chassis or the floor-pan.

Bevel box	means a type of steering box that is used to effect a dramatic change in direction, such as those used in forward-control vehicles like vans and trucks, also known as a right-angle drive box.
Big-block	is a term used for a family of V8 engines, as produced by most major North American motor vehicle manufacturers (in particular Ford, General Motors, and Chrysler) which in comparison to 'small-block' engines, are very large in external dimensions, and heavy.
Blue-dot	means a small accessory cosmetic lens incorporated as part of a stop-lamp lens, that causes a purple-coloured hue to be emitted when the stop lamp is illuminated.
Boss	means a section of steel material designed to absorb a high level of load, used to reinforce the area of the component in which it is incorporated.
Boxed	means to add a capping plate to convert a c-section or channel-section chassis rail or cross-member to a fully enclosed section like an RHS.
B-Pillar	means the center body pillar, used in most vehicles to connect the sill to the roof, and to latch the front doors, and in the case of most four-door vehicles, also to hinge the rear doors. A B-pillar is also known simply as the 'post', or the 'B-post'. On a true 'sports coupe' body style, these pillars terminate at the bottom of the window line, leaving an uninterrupted glass area along the sides of the vehicle.
Brake-fade	means the reduction of braking performance resulting from overheating of friction surfaces, due to prolonged or excessive use.
Brinelling	means the premature wear of a drive-shaft universal bearing due to a lack of rotary movement.
Build approval	means the process specified in 'Chapter 4 – Build Approval Process'.
Bump-steer	means the change in steering geometry of the steered wheels that can occur if one or more steering geometry principles are not correctly designed into the vehicle's steering system, as the steered suspension of the vehicle moves throughout its range of extension and compression.
Bump-stop	means a compression spring, usually of rubber, that prevents contact, or reduces the severity of contact, between the vehicle structure and a suspension component, when the vehicle's suspension system encounters a bump that causes the suspension to fully compress.
B-Zone	means the remaining area within a passenger compartment surrounding the A-Zone, but does not include the C-Zone.

Camber	means the angle between the plane of a wheel and the vertical axis of a vehicle, when viewed in end elevation.
Cant rail	means the interior roof structure sections in a vehicle with a fixed roof, which span the length of a vehicle directly above the side windows.
Capped	means to add a capping plate to convert a c-section or channel-section chassis rail or cross-member to a fully enclosed section like a RHS.
Cardan-shaft	means a parking-brake system that uses the drive-shaft for braking, rather than the wheels.
Caster	means the angle between the steering axis and the vertical axis of a vehicle, when viewed in side elevation.
Centre-lock	means a type of wheel attachment system, that relies on a single central method of location, such as a splined hub, rather than conventional multiple wheel nuts or bolts.
Chamfered	means the application of a radius, to give a smooth rounded shape to an edge or a corner.
Chassis	means the supporting frame or platform of a motor vehicle to which the major mechanical components and body attach.
Chassis inspection	means an inspection made by an LVV Certifier, of a vehicle at an early stage of its construction, ideally when the chassis is tacked together but not fully welded.
Chrome-moly	means a special high grade of steel that has been alloyed with small amounts of Chromium and Molybdenum, often used in top-level race car chassis and components.
Circlip	means a type of fastener consisting of a sprung ring with open ends which can be snapped into place within a machined groove on a cylinder or other part to allow rotation, but to prevent lateral movement. Circlips, otherwise known as 'snap-rings', are often used to secure pinned connections, and can be used internally or externally.
Clevis joint	means a yoke, with a hole formed or attached at one end of a rod.
C-notch	means a chassis modification where a 'C' is notched out of the rear chassis rails to increase axle housing clearance during suspension compression, usually carried out in conjunction with significant suspension lowering.
Cornering lamp	means a lamp designed to emit light at the front of a vehicle to supplement a vehicle's headlamps, by illuminating the road ahead in the direction of the turn.

Cotter pin	means a bolt, wedge, key, or pin, inserted through a slot, in order to hold two or more components together.
C-Pillar	means the rear-most pillars on a sedan body-style of vehicle, that support the rear window and the rear of the roof, and to which the rear doors usually latch.
Crush-tube	means a section of non-compressible material that is positioned within a cavity, through which a fastener passes, to prevent collapsing of the material surrounding the cavity, and consequential loosening of the fastener.
Custom	means a service provided, or a component or system manufactured, by an individual or a company who is not a high-volume motor vehicle manufacturer.
C-Zone	means the area within a passenger compartment that is: ▪ below the horizontal plane measured at the lowest point of the front seat cushion; and ▪ behind, and following a plane extending upward, parallel to the back of the backrest on the rearmost seat; and ▪ provided that no front centre seating position exists, the width of the dashboard and centre console surface area, which may not exceed 140 mm (5 ¾") on either side of the longitudinal centerline of the vehicle; and ▪ the area forward of the steering wheel or control, defined as a forward horizontal projection of an area 400 mm (16") across, circumscribing the upper-most end of the steering column, provided that no fittings, controls, or surfaces are positioned closer than 100 mm (4") from the dashboard surface to the steering wheel; and ▪ any part of the dashboard and instrument panel between the edge of the area specified and the nearest inner pillar or sidewall area; and ▪ any window glass or window glass framing; and ▪ roof bows and related components within a hood frame of a convertible vehicle; and ▪ any area which is unable to be contacted by a 165 mm (6 ¾") diameter head-sphere; and ▪ any other areas which could not reasonably be expected to be contacted by an occupant in the event of a front, rear, or side impact, or roll over.
Daytime-running lamp	means a lamp designed to emit a low-intensity light forward of a vehicle, to make it more easily seen in the daytime.

Dead perch	means a fixed spring mount, rather than a shackle mount, used on the passenger side of a transverse leaf spring used to suspend a beam axle at the front of a vehicle, designed to prevent lateral movement of the axle.
Doubler plates	means a pair of plates that clamp together on either side of a part of a vehicle structure, commonly used as a seat anchorage or a seatbelt anchorage system.
Double shear	means an attachment method that supports a component on both sides, rather than the cantilever effect applied by a single-shear attachment system.
Drag-link	means the link in a steering system that connects the steering box pitman arm or drop arm to the stub axle steering arm.
Dropping	means the traditional hot rodding method of 'stretching' an old I-beam axle, to lower a vehicle's ride height.
Eccentric	means, in the context of this manual, a bush that incorporates an attachment hole that is offset from the central axis of the bush.
Elastomeric	means a type of material made with such properties so as to be able to return to its natural shape, when a deforming force is removed.
Electrolysis	means a chemical reaction that occurs to metals during an electroplating process.
Engine hood	means a hinged body panel that gives access to the engine compartment of a vehicle, also known as a bonnet.
ERW	is an abbreviation for electric resistance welded, which is a common type of steel tubing material.
Fabric damper	means a device incorporated as part of a steering system on some vehicles, positioned between the steering box and the steering column, designed to isolate road shocks from being transferred to the steering wheel.
Fascia	means a panel or molding immediately below the windscreen on a vehicle's interior, usually facilitating the mounting of instruments, air vents and accessories.
Fiddle-brakes	means a mechanical device that allows the individual operation of left side and right side brakes, used to achieve very tight cornering in off-road vehicle competition activities.

Final inspection	means the last inspection that takes place when a vehicle undergoing LVV certification is able to be driven, after which, rectifications aside, the vehicle is able to be issued with an LVV certification plate, and go through the entry compliance and registration process.
Fish-plate	means a plate that is positioned on one side of the chassis rail to reinforce the point at which two or more chassis sections join. A fish-plate can be positioned on either the outside or the inside of the chassis rail.
Frost plug	means a plug that is pressed into an engine block or cylinder head to contain the coolant in the engine's water jackets.
Funny car	means a type of drag racing vehicle, based on a one-piece replica fibre-glass or carbon fiber automotive body, mounted over a purpose-built front-engined chassis.
'G'	is an abbreviation for G-force, which is a unit of force equal to the force exerted by gravity, used to indicate the force to which a body is subjected, when accelerated or decelerated.
Gross vehicle mass	means the maximum legal weight at which a vehicle can be operated, including the vehicle's tare, and its payload.
Grub-screw	means a screw with a bearing point on one end, used to hold something in place when tightened against a mated surface.
GVM	is an abbreviation for gross vehicle mass.
Header	means a special exhaust manifold designed for maximum efficiency and to reduce exhaust back pressure, thereby increasing engine power.
Heim joint	means an eye-end joint, or ball and socket joint, incorporating a spherical bearing, also known as a 'rose' joint.
Hip-bar	means a section of roll-bar or roll-cage that extends forward from approximately the mid point of the main hoop, running longitudinally past the front seat at about hip level, to the mid-point or base of the A-pillar area.
H-frame	means a frame which provides a method of identifying the h-point, for the purpose of serving as a reference point for establishing various critical safety-related measurements, including the permitted areas for upper and lower seatbelt anchorages.
Hookes-type joint	means a simple type of universal joint in which the shaft ends are connected by yokes disposed at right angles, and transmit torque by way of a cruciform bearing mounting.

H-point	means a reference point, which indicates the hip position of an occupant in a normal seated position.
I-beam	means a rigid transverse axle, cast or forged in an I-beam section, upon which the wheels are mounted.
IFS	is an abbreviation for independent front suspension.
Independent suspension	means a type of suspension that enables a wheel on one side of an axle to absorb changes in a road surface without affecting the other wheel on the same axle.
IRS	is an abbreviation for independent rear suspension.
Jamb-nut	means a nut usually used to lock an internally threaded section in a specified position against another externally threaded section.
Keeper spring	means a secondary spring, commonly used as a method of tensioning the primary spring in an adjustable platform suspension system.
Kevlar	is a brand name for a particularly light but very strong aramid-fibre, manufactured by the DuPont Company.
Kg	is an abbreviation for a kilogram.
Kinetic energy	means the energy possessed by a body or an object because of its motion.
King-pin	means a predominantly vertical shaft from which a steered wheel assembly pivots.
Kph	is an abbreviation for kilometres per hour.
'L'	is an abbreviation for a type of stainless steel, that denotes a low carbon content, which means that it is a material that can be successfully welded.
Ladder chassis	means a chassis in which parallel side members are joined at intervals by transverse beams, giving the appearance of a ladder.
lb	is an abbreviation for the imperial measurement of pounds.
L-class	is a New Zealand Transport Agency classification, which means, in very simple terms, a two or three-wheeled motor vehicle.

LED and LED array	is an abbreviation for a light emitting diode, which is a relatively new type of automotive light source, now becoming a common alternative to lights that are illuminated by a conventional light bulb.
Line-lock	is a device based on an electronic solenoid that controls a valve, which is in line with the front brakes. Normally, the valve is open and allows fluid to pass through to the front brakes, however, while the front brakes are applied and the solenoid is activated, the valve closes to trap the fluid in the front brakes keeping them applied until the control is released.
Linish	means the process of using grinding or belt sanding techniques to improve the flatness or smoothness of a surface.
Locked diff	means a differential that drives both left and right side axles simultaneously without the usual mechanical slippage designed into production motor vehicles to provide smooth and comfortable cornering.
Locost	is the brand name for a popular sports car design based on the Lotus 7, intended as an entry-level do-it-yourself sports car for the home-builder.
Loctite	is a unique bonding resin that hardens in the absence of air, that is commonly used to prevent fasteners from vibrating loose.
Longitudinal	means in the fore-aft direction, running on or parallel to the centre-line of the vehicle.
Low Volume Vehicle	the legal definition is currently under review, but is intended to mean a vehicle that is built or modified in small numbers, and includes individual home-built or modified vehicles.
Low Volume Vehicle Technical Association	is an incorporated society established to represent the interests of vehicle modifiers and builders in New Zealand. The LVVTA owns and administers the Low Volume Vehicle Code, and is made up of 10 member associations, one of which is NZHRA.
LVV certification plate	means an aluminium plate, approximately 110 mm x 80 mm in size, that is manufactured for the LVV Certifier by LVVTA, and is engraved with all of the modification or construction details unique to the vehicle in question, which is attached to the vehicle structure, and confirms the vehicle's legality to Police, entry certifiers, and warrant of fitness inspectors.
LVV Certifier	means a person appointed by the New Zealand Transport Agency to inspect and approve modified and scratch-built vehicles, under the Low Volume Vehicle Code.

LVVTA	is an abbreviation for the Low Volume Vehicle Technical Association Incorporated, and is the owner of this NZ Car Construction Manual.
'mm'	is an abbreviation for the metric measurement of millimetres.
'm'	is an abbreviation for the metric measurement of metres.
MacPherson-strut	means a telescopic independently sprung suspension member incorporating a shock absorber, which is fixed at its upper end to the body shell or chassis, and has the lower end located by linkages which control transverse and fore and aft movement.
Metallurgist	means a person who studies the physical and chemical behaviour of metals, in particular the composition and mixture of their elements.
MIG	is an abbreviation for metal inert gas, which is a continuous welding system that uses an electrical arc, and incorporates a gas to protect the weld.
Modified production	the legal definition is currently under review, but is intended to mean a vehicle that, although modified, still maintains a sufficient percentage of body or chassis from one primary mass-produced vehicle, that it can still be considered to be that vehicle.
'Moon' tank	means a fuel tank manufactured by the Moon Equipment company of Southern California, which in the context of this manual, is of a style that is traditionally used in hot rods, mounted ahead of the vehicle's grille and above the front axle.
Monocoque	means the same as unitary construction.
Mph	is an abbreviation for miles per hour.
N	is an abbreviation for the metric measurement of a newton.
NDT	is an abbreviation for non-destructive testing.
Necking	means the narrowing of the beam section that occurs in an I-beam axle if the dropping process is carried out without the correct amount of heat being applied.
Neutral axis	means, in the context of this manual, to be drilled through the sides (on a horizontal plane), rather than from top to bottom.
Newton	is the amount of force required to accelerate a 1 kilogram mass by 1 metre per second per second.

Nm	is an abbreviation for the metric measurement of a newton metre.
Newton metre	is equal to a torque of 1 newton applied over a 1 metre long lever.
New Zealand Hot Rod Association	is the organisation that administers hot rodding within New Zealand, and is a founding member of the LVVTA.
Nitrous oxide	is a liquid chemical composition of one part of nitrogen and two parts of oxygen, which when introduced with the fuel mixture entering an internal combustion engine, converts to a gas and may increase the oxygen content in the combustion chamber producing a momentary increase in power output.
Non-destructive testing	means, generally, one of the many different types of crack-testing available.
NOS	means a nitrous oxide system.
Nylock	means a type of vibration-proof locking nut that incorporates a nylon section, which enables the nut to lock itself against the corresponding bolt.
NZDRA	is an abbreviation for the New Zealand Drag Racing Association Incorporated.
NZHRA	is an abbreviation for the New Zealand Hot Rod Association Incorporated.
NZTA	is an abbreviation for the New Zealand Transport Agency, a crown entity.
OE	is an abbreviation for original equipment, usually referring to equipment supplied by a high-volume vehicle manufacturer.
OEM	is an abbreviation for original equipment manufacturer, meaning a high-volume vehicle manufacturer.
Oil-canning	means the fatigue-induced cracking brought about by constant movement the two joined sections of material, usually as a result of poor attachment design.
Osmosis	means the diffusion of fluids through a semi-permeable membrane or porous partition, often found in the automotive world as moisture absorbed and trapped in fibre-glass, resulting in blistering or bubbling of the outward surface.

Overlay	means a thin layer of clear or colored plastic that is folded, formed or coated over glass.
Panhard bar	means a transverse rod pivoted at one end from the chassis or body structure to a beam axle or differential at the other end, in order to constrain the axle or differential's lateral movement.
Passenger compartment	means the part of a vehicle body that houses the passengers and driver.
Passivating	means, in the context of this manual, a corrosion-resistant coating, usually gold in colour.
Payload	means the maximum weight that a vehicle manufacturer certifies that a vehicle can carry.
PBR	means a manufacturer of braking system components, used in mass-produced vehicles throughout the world.
Perimeter	means the distance around the outside of an object.
Photometric	means the process of measuring the intensity of illumination from a particular light source, and comparing it with that produced by a standard source.
Pitman arm	means the levering arm in a steering system that connects the steering box output shaft to the drag-link, also known as a drop arm.
Porosity	means the density of a material, and its capacity to pass liquids through it.
Preliminary inspection	means the inspections, generally between one and four, that take place before the final inspection when a vehicle undergoing LVV certification is able to be driven.
Pro-street	means a particular style of hot rod or street machine vehicle that features typical drag racing vehicle attributes and characteristics in order to achieve a performance-oriented look, including large wheel tubs to accommodate extremely large rear tyres, low stance, and a powerful (sometimes supercharged) engine.
Push-lock	means a type of hose and fitting system that enables the hose to be easily pushed on, however because of the design of the male fitting, the hose grips against the male fitting such that its removal is very difficult.
Push-pull drag-link	means a linkage that runs longitudinally, connecting a steering box that is mounted near the firewall, forward to the steering arm.

Rag coupling	means the same as a fabric damper.
Reaction rod	means a control rod used to locate a suspension arm, and commonly used to resist brake loadings, also known as brake reaction rods or strut rods.
Rectangular hollow section	means a configuration of steel section commonly used in the manufacture of chassis, and other motor vehicle component fabrication.
Retro-fitment	means the fitting of a component or system that was not originally installed during the construction of the vehicle by the vehicle manufacturer.
Retro-reflector	means a reflective surface fitted to the rear of a motor vehicle, used to reflect light back to the light source, commonly known simply as a reflector.
RHS	is an abbreviation for rectangular hollow section, a common steel section used for chassis building.
Riv-nut	is a type of captured nut that can be attached to any part of a vehicle, using the same attachment principle as that of a rivet.
Roll-bar	means a transverse bar, or bars, positioned behind the front seating positions, which is attached and longitudinally braced to the main structure of the vehicle.
Roll-cage	means a roll-bar with additional members extending forward past the front seating positions to another roll-bar positioned around the top of the windscreen area.
Roll-control	means a device intended for drag racing, to enable the front brakes to be locked on, without the rear brakes being engaged, enabling the burnout process to occur without the engine fighting against rear brake pressure.
Roll-over one-way check-valve	means a safety-valve installed in the fuel tank breather line which operates in only one direction, which prevents fuel from coming out of the breather line in the event of a roll over.
Rose-joint	means the same as a 'heim' joint.
SAE	means the Society of Automotive Engineers.
SAE 4130	means a grade of steel that has a low alloy and low carbon content, that features excellent welding and machining properties, and can be readily heat-treated.

Schedule-A	means the driver and vehicle safety requirements contained in the MotorSport New Zealand rulebook.
Scratch-built	legal definition is currently under review, but is intended to mean a vehicle that is built from the ground up, and contains so little body, chassis, or componentry from any one particular mass-produced vehicle, that it cannot be considered a modified production vehicle.
Semi-elliptic	means a type of leaf spring, that is positioned longitudinally, usually supporting a beam axle or a differential, arranged as a compressed semi-circle, and mounted at points both forward and rearward of the axle or differential.
Servo	means a control system that converts a small mechanical motion into a corresponding motion that produces much greater power, in the case of a braking system, through the use of engine vacuum.
SFI	is an abbreviation for the Snell Foundation Incorporated.
Shifter	means a device provided for the operation of changing gears.
Shimming	means the installation of a thin washer to adjust or fill a gap between machined parts, especially gears.
Sintering	means a method for making objects from powder, by heating the material (below its melting point) until its particles adhere to each other. Sintered bronze in particular is frequently used as a material for bearings, since its porosity allows lubricants to flow through it.
Small-block	is a term used for a family of V8 engines, as produced by most major North American motor vehicle manufacturers (in particular Ford, General Motors, and Chrysler) which in comparison to 'big-block' engines, are very compact in external dimensions, and lightweight.
Snell Foundation Incorporated	is an organisation involved in the setting of safety standards in relation to motor-sport.
Space-frame chassis	means a chassis that is built to give the advantage of lightness and rigidity, by using predominantly straight small-diameter tube sections, arranged in a fully triangulated truss-like design, with some tube sections acting in compression and others acting in tension. The rigidity of the space-frame chassis relies on the configuration and the spacing of the tube sections acting in unison to contribute to the overall strength.
Spindle	means the machined section that the hub bearings run on, otherwise known as the 'pin' or 'axle'.

Spool	means a type of ring and pinion carrier assembly designed specifically for drag racing, that does away with side gears and spider gears, which when fitted, has the effect of a locked differential.
Spud	means, in relation to a suspension arm, a threaded heavy wall section of material used to accept a rod end, that is welded into a lighter wall section of tubing.
Spring shackle	means an attachment system designed to support the end of a spring, whilst permitting the spring to vary in length as it deflects upward and downward from suspension compression and extension.
Steel bundy	means not a statue of Mark Stokes, but a type of steel tubing material for the manufacture of brake fluid pipes.
Stressed seat	means a seat that has one or more seatbelt anchorages attached to the seat frame in such a way that any loading applied to the seatbelt anchorage would be transmitted through the seat structure to the seat anchorage.
Stub axle	means the outer part of the suspension assembly, to which the brake and wheel assemblies attach, also known as an upright.
Surge tank	means a small tank used to hold the fuel to prevent fuel from moving away from the fuel pump pickup during cornering, acceleration, and braking.
Swaged fitting	means a type of compression fitting used with metal tubing, that offers a high degree of long term reliability, consisting of a male half of the fitting which has a straight thread and an angled front face (usually 45° or 37°). A matching nut is placed on the tubing, and a flaring tool is used to flare the end of the tubing outward at the same angle. The nut is then tightened, compressing the flared portion of the tubing between the male fitting and the nut.
TAC	is an abbreviation for the Technical Advisory Committee.
Tare	means the unladen weight of a vehicle.
Technical Advisory Committee	means a committee, comprising scratch-built vehicle experts, appointed by, and operating under, the Low Volume Vehicle Technical Association. The TAC primarily consists of NZHRA club members, but includes some members of other vehicle enthusiast groups.
Tie-rod	means the steering track-rod or cross-rod, or any nominally transverse linkage that directly or indirectly actuates steered wheels.
Tie-rod end	means a mechanical joint in which a spherical end moves freely within a recessed socket, typically used on steering linkages.

TIG	is an abbreviation for tungsten inert gas, which is a type of arc welding.
Toe-in	means the setting of paired wheels on an axle so that the leading edge of each wheel is inclined slightly inwards.
Toe-out	means the setting of paired wheels on an axle so that the leading edge of each wheel is inclined slightly outwards.
Torsional	means, in the context of this manual, the rotational twisting loads applied throughout the length of a chassis during vehicle operation.
Torque	means a force that produces a twisting or rotating motion.
Torque (engine)	means the amount of twisting effort exerted at the crankshaft by an engine, expressed in foot-pounds of force. A foot-pound represents the force of one pound acting at a right angle to the rotating crankshaft, at a distance of one foot in length.
Traction control	means a system designed to prevent loss of traction, and therefore the loss of control of the vehicle, when excessive throttle or steering is applied by the driver.
Transverse link	means a suspension link or rod that, whilst allowing full suspension travel, locates the suspension in the east-west direction.
Trunk-lid	means a hinged lid or cover, designed to give access to the rear luggage compartment, also known as a boot.
TSDA	is an abbreviation for a transport service delivery agent, which is a people or company appointed by the New Zealand Transport Agency to provide entry and in-service (WoF and CoF) inspections.
UHMC	is an abbreviation for ultra-high modulus carbon.
UNF	is an abbreviation for unified screw thread 'fine'.
Unitary-construction	means a type of vehicle construction that incorporates the vehicle body and chassis frame in one unit, as opposed to having a separate and removable chassis.
Unstressed seat	means a seat that does not have any seatbelt anchorages attached to the seat frame.
Vehicle identification number	is a 17-digit numbering system used world-wide as a primary means of individually identifying motor vehicles.

Vehicle Inspection Requirements Manual	means the New Zealand Transport Agency's set of legal requirements that is used by a TSDA to assess vehicle compliance in a Warrant of Fitness inspection.
VIN	is an abbreviation for 'vehicle identification number'.
VIRM	is an abbreviation for the Vehicle Inspection Requirements Manual.
VLT	is an abbreviation for visible light transmittance.
Watts linkage	means a three-element linkage typically used to control rear axle transverse movement.
Witness hole	means a hole drilled into a suspension linkage, to enable an inspection to determine that sufficient thread engagement of a threaded joint has been achieved.

About the Author

From the New Zealand Hot Rod Association (Inc) Executive Committee, 2007.

The New Zealand Hot Rod Association has been involved in low volume vehicle certification from its inception by the Government. It was through the foresight of Tony Johnson, then President of NZHRA, that NZHRA was able to prevent new legislation from being introduced that threatened the very existence of the hobby of hot rodding. Tony negotiated with the Ministry of Transport for NZHRA, to find ways to implement vehicle certification for modified vehicles that would retain the integrity of hot rodding, while at the same time complying with new safety compliance measures. His proactive stance on low volume vehicle certification initially caused some consternation among some NZHRA members, but it is now clear to everyone that the outcome has been the establishment of an excellent system, which has enabled NZHRA to continue to ensure that its members' vehicles are still able to be built with very few restrictions, provided that they are constructed safely.

By the time vehicle certification for modified vehicles was introduced by the Government in 1992, Tony, along with the assistance of the NZHRA Executive Committee and the Technical Advisory Committee of the day, had written the first Code of Construction Manual as a guide to both hot rodders and other vehicle builders. He continued to work on behalf of NZHRA with the Government to make vehicle certification as practical as possible for rodders, involving setting up the systems, and appointing and training the best of our own hot rod builders around New Zealand to become the LVV Certifiers. It was at his suggestion that NZHRA introduce 'retrospective certification' to ensure that all the modified vehicles owned by NZHRA members were safely built, which showed commitment and good faith to the Government at a critical time, and over the years has resulted in a major improvement in the safety of many of the vehicles that NZHRA members and their families travel in. Tony has also been responsible for setting up a Fender Exemption system that NZHRA is able to administer itself, which allows NZHRA members to run vehicles without fenders in the true traditional style of hot rodding, free of the old 'to and from hot rod events only' restrictions.

Tony was President of his home club Wanganui Road Rodders for many years, and was given Life Membership in 1988. He became President of NZHRA in 1989 and held that role until 1995, and in 1994 was given Life Membership of NZHRA in recognition for his work for hot rodding. Upon the establishment of the 'single-certification system' in 1996 he became the Technical Officer of LVVTA and has been LVVTA's Chief Executive Officer since June 2003. This CEO role has enabled him to continue to help all other car builders as well as hot rodders by liaising with Government policy-makers on behalf of LVVTA and its member organisations, by working through vehicle safety issues with the Government to ensure that we are able to continue to enjoy hot rodding, and car building and modifying in general as we know it. In 2003 Tony became the recipient for the prestigious 'Meguiar's Collector Car Hobby Person of the Year Award' for his services to all car hobbyists New Zealand-wide, the highest distinction that someone can achieve in the car hobby in New Zealand. In 2008 the New Zealand Government awarded Tony with a Road Safety Trust Innovation and Achievement award for the development of this Car Construction Manual.

Tony started writing this manual as a replacement to the1992 Code of Construction Manual for NZHRA in 2000. Through Tony's many skills and strong general automotive and hobby car knowledge, he has done (other than the CAD-diagrams) everything himself, including the manual's concept and design, co-ordination of technical input, technical writing, type-setting, formatting, editing, the many car illustrations, and even the cover artwork. This has saved NZHRA a great deal of money, and has achieved a document that is probably the best of its kind in the world.

The Executive Committee of NZHRA and its members would like to extend their sincere thanks to Tony for this manual, and for his 20-plus years of devotion to the safety of our sport, and its future. This excellent document will always be a tribute to your dedication. Thank you TJ.